Letter to a Beginner

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Observing Interacting Galaxies

Photographing Faint Nebulae

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Spring 1987

The Great LMC Supernova

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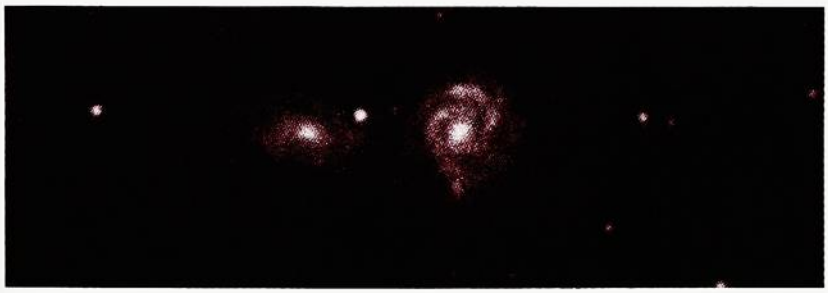

Observing Interacting Galaxies
by Alan Goldstein

8 *The Whirlpool Galaxy in Canes Venatici is one of the sky's bright, showpiece galaxies. Yet how many people think of the Whirlpool as an interacting galaxy? Alan Goldstein reports that the spring sky holds many interacting galaxies observable with backyard scopes.*

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16 *Most experienced backyard astrophotographers know how to go after M42 and M104, but what about faint deep-sky objects? Mace Hooley offers tips on how to successfully record Barnard's Loop, S147 in Taurus, and Gemini's IC 443.*

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by Dick Suiter

22 *Dear Beginner: You've come to me for advice on getting a telescope and accessories. Well, I'm not going to tell you. Instead I'm going to tell you to form an observing group. Want to know why? Turn to page 22 . . .*

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ON THE COVER: IC 5067/70, the Pelican Nebula in Cygnus, photographed by Robert Provin and Brad Wallis, who used a 4.5-inch f/6.7 astrograph, hypersensitized Tech Pan film, and a 120-minute exposure.

Inside View

Observers Archinal, Kerns, and Burns pose in Columbus.

How many times has a friend coerced you into observing when you wouldn't have observed alone? How many members of your astronomy club offer you advice or have expertise in an area you need help with? The benefits of knowing others whose knowledge and enthusiasm can help you are numerous, and this is the topic of Dick Suiter's article, "Letter to Beginner," on page 22. Dick contends that the most important move you can make as a neophyte observer is to form an observing group, an interactive circle of observers who together equal more than the sum of the parts. (Since Dick is camera-shy, he included a photograph of his friends Brent Archinal, John Kerns, and Tom Burns.)

This article isn't just for beginners. It's never too late to make new friends and form new partnerships in a hobby that is as dependent on fresh information and outlooks as backyard astronomy is. Suiter's message may have an impact on the way you relate to other observers of the sky.

The big news in astronomy these days is, of course, the supernova in the Large Magellanic Cloud. Discovered on February 24 by Ian Shelton of the University of Toronto, supernova 1987A is the brightest such exploding star recorded in 383 years. Because of its distance (53 kiloparsecs) and because it lies inside the LMC, it will be immensely useful to astrophysicists for a number of reasons. A detailed report on the supernova by Richard Talcott of ASTRONOMY magazine will appear in the summer *Deep Sky*; this issue contains information and photographs from the exciting first days of the supernova.

The summer issue of *Deep Sky* will mark the tenth anniversary of this magazine, which includes its earlier incarnation as *Deep Sky Monthly*. It'll be a special issue with a bit of reminiscing and an introduction of the people who bring you *Deep Sky*.

I expect to be at the Texas Star Party in Fort Davis, Texas (May 25-30), Darksky '87 in Santa Fe, New Mexico (June 22-26), the Astronomical League/Astronomical Society of the Pacific/Western Amateur Astronomers convention in Pomona, California (July 11-17), and Astrofest in Kankakee, Illinois (September 18-20). I look foward to meeting all of you who are present.

Yours truly,

Dave Eicher
Editor

Letters to DSM

In Defense of Sir John

Dear Dave / Once again, all of us *Deep Sky* readers are indebted to Richard Berry for his wonderful map of the southern RNGC objects. It is a striking portrait of the distribution of nearby galaxies.

There is one aspect of the article that bothers me, however. Richard speculates that the relative paucity of galaxies south of −40° probably occurred because Sir John Herschel was distracted by the wondrous sights of the southern sky. However, several lines of evidence point to just the possibility that is dismissed at the end of the article: that there really *are* fewer bright galaxies in the south than in the north!

Let me say a few words about Sir John and his journey to the Cape of Good Hope. He made this trip *expressly* to finish sweeping the sky so he could better understand the "construction of the heavens." Richard, of course, stated this at the outset of the article. What he failed to state clearly is that Sir John, as one of the outstanding scientists of his time, took this responsibility *very* seriously.

He certainly did spend much time observing the Large and Small Magellanic Clouds and the Orion and Eta Carinae nebulae. He was perfectly placed for the 1834/5 apparition of Halley's Comet and spent a great deal of time observing it. Readers of Gunther Buttmann's enjoyable biography know Sir John also continued his studies of the flourishing plant and animal life he found in South Africa, making many sketches, measurements, and observations that biologists and zoologists around the world used for years afterward. On top of all that, he found time to become intensely involved in the social and political life of the Cape, not only dining frequently with the governor and other dignitaries but also helping to improve the schools and cultural life. He had distractions aplenty and not just celestial ones!

Nevertheless, the sweeps came first. During forty-seven months of observing at the Cape he made a total of 380 sweeps and covered the southern sky as carefully as his telescope would allow. This works out to an average 8.1 sweeps per month. If we look at each month throughout the year, we find that only August is significantly deficient in sweeps. In all other months the average number of sweeps is not significantly different from the overall average.

The number of sweeps is shown in an accompanying table. The table also shows the right ascension crossing the meridian at midnight on the 15th of each month (give or take a few days). This right ascension runs through the part of the sky to which Sir John would have had easiest access to make his sweeps at that particular time of year. Now, if he had stolen time from his sweeps to make his special studies of the two Magellanic Clouds, and the Orion and Eta Carinae nebulae, those parts of the year when these objects were crossing the meridian at midnight ought to be deficient in sweeps. As you can see, they aren't. In fact, three of these four special objects transit at times of the year when Sir John was actually making more sweeps than average.

While Sir John may have possibly made shorter sweeps than average to study the special objects, I am pretty well convinced he did not. We would have to dig into the Herschel Archives at the Royal Astronomical Society's Burlington House library in London to give a definitive answer to this, but there isn't any need to. We can turn to the sky itself and to the way the NGC (and hence the RNGC) was put together.

If we look closely at the *DSM* map, we can see the actual lack of objects Richard noticed sets in at around −25°, or even −20° declination, not −40°. The reason for this is simple: Sir John was the only person to systematically explore the southern sky with a moderately large telescope before the NGC was compiled. Yet his instrument was dwarfed not only in size but also in sheer numbers by many telescopes in regular use in the northern hemisphere. The excess number of nebulae *discovered from the north* actually accounts for far greater numbers there than in the south. So, if we are to compare the numbers of northern versus southern galaxies, we must remember that it was Sir John and his 18.7-inch reflector against the multitudes. All the effort in Europe and America overwhelmed any hope for even numbers of nebulae in the NGC north and south of the celestial equator.

A far fairer test of Sir John's dedication to sweeping and his ability to find nebulae in the south would be to com-

Numbers of John Herschel's CGH Sweeps by Month

Month / Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1834	—	—	6	11	8	9	14	9	11	10	9	12
1835	12	13	13	13	14	14	10	3	10	7	9	13
1836	10	9	10	5	5	10	15	2	7	8	9	8
1837	10	6	8	6	0	6	0	0	6	0	3	5
1838	2	—	—	—	—	—	—	—	—	—	—	—
Average	8.5	9.3	9.3	8.8	6.8	9.8	9.8	3.5	8.5	6.3	7.5	9.5
R.A.*	7:30	9:30	11:30	13:30	15:30	17:30	19:30	21:30	23:30	1:30	3:30	5:30
			Eta Car						SMC		Orion LMC	

* Right Ascension on meridian at midnight on 15th of month.

Mean number of sweeps per month = 8.09
Mean error in the mean = 0.06
Standard deviation = 4.09
Total number of months with sweeps = 47

pare those discovered *only* by him and by his father with their very similar instruments. When we do this, we find the north/south ratio is somewhat closer to being even. Yet there are *still* significantly greater numbers of nebulae in the north as compared to the south. Was Sir John indeed more careless at the Cape than he was at his English home in Slough?

To answer this question we need to turn to the modern catalogues. The catalogue most nearly matching that of the Herschel's in the sky coverage and depth is the famous Shapley-Ames catalogue, prepared at Harvard in the late 1920s and early 1930s. This catalogue is still the only photographic galaxy catalogue that has covered the entire sky in relatively homgeneous fashion to a relatively homogeneous limiting magnitude.

You published two of the Shapley-Ames plots showing the galaxies included in their catalogue in Richard's article in *DS*#14. This objectively chosen sample of galaxies, closer in limiting apparent magnitude to the Herschels sample than any other, shows the same thing Sir John and his father found: *There are more bright galaxies in the north than in the south.*

If we take a subset of the Shapley-Ames galaxies, say just those brighter than 12th magnitude, the effect grows even more pronounced. While there are perhaps 30 or 35 percent more galaxies in the north in the Herschels' lists, and around 50 or 60 percent more in the north in the Shapley-Ames catalogue, there are fully twice as many bright galaxies in the north as in the south. Even in Sharp's combined list there are 205 more northern galaxies than southern galaxies. (This shows up best in his Figure 4b of his *PASP* paper, a figure you and Brian Skiff unfortunately chose not to publish.) This inequality persists to levels as faint as 17th magnitude. Professor de Vaucouleurs has a fine review paper in the April 1971 *PASP* (Volume 83, pages 113 to 143) that discusses in detail the inhomgeneous distribution of galaxies over the sky.

I hope you will be able to publish Richard's charts as a poster. Richard has done a fine job, and I'd be sorry not to see the charts displayed in their full glory.

Harold G. Corwin, Jr.
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Austin, TX 78712

DARKSKY '87 in Santa Fe

Dear Dave / I look forward to seeing many contributors to *Deep Sky* attending our visual astronomy conference called DARKSKY '87. Besides David Levy, Jack Marling, and you, Lee Cain will be coming out with one or two of his giant binocular telescopes.

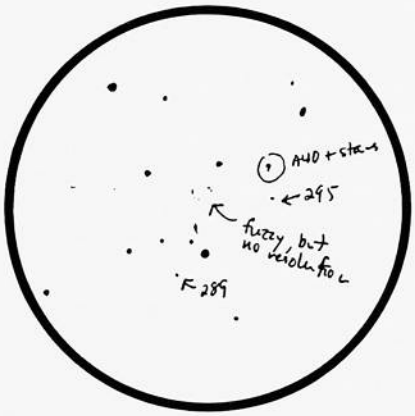
We offer up to nine days of observing with a substantial number of large telescopes. The conference week of June 22 through 26 is the driest, most pleasant week in the Santa Fe summer and will be free of moonlight. Family members who don't want to stay up all night may want to enjoy Santa Fe as a resort and vacation spot.

If readers are interested in attending, they can obtain a brochure by calling 1-800-DARKSKY or writing me.

Bill Georgevich, Co-Chairman
DARKSKY '87
535 Cordova Road, Suite 130
Santa Fe, NM 87501

Globulars in M31

Dear Sir / Recently I was surprised to see images of two of M31's globular clusters on some piggyback photos I made with a 200mm f/4 lens. Subsequently I searched for these two objects (labeled G289 and G295 by Skiff in the Fall 1984 *Deep Sky*) visually with my 5-inch SCT. What I believe to be G295 was easily visible to direct vision at 39x to 125x. G289 was apparent to averted



Sketch by Dave Gard

vision at higher magnifications. I was surprised to see these objects because the brightness of most of the M31 globulars is less than 13th magnitude. I would estimate G295 at magnitude 12 and G289 at magnitude 12.5 to 13. These magnitudes were not included in Skiff's article. Could you confirm these estimates? Have you heard of anyone else observing these objects with small telescopes?

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Deep-Sky Stats from *Burnham's*

Dear Mr. Eicher / A few years back I conducted a rather in-depth study of the objects listed in *Burnham's Celestial Handbook*. Since this three-volume set is very popular with deep-sky observers, I think your readers may be interested in what I found.

My procedure was to count the objects listed in each category occurring in each constellation. The results are enclosed and include two separate pages of data. The principal results, however, are as follows:

Objects listed in *Burnham's*:

5,357 double stars
2,681 variable stars
1,913 deep-sky objects

9,951 total

The most interesting breakdowns follow. Most objects in a constellation: 383 in Virgo. (Cygnus pulls a close second with 379.) Most double stars in a constellation: 200 in Cygnus. (Centaurus ranks second with 165.) Most variable stars in a constellation: 145 in Cygnus. (Sagittarius is second with 116.) Most deep-sky objects in a constellation: 219 in Virgo. (Ursa Major pulls a second with 115.)

However, since constellations vary greatly in size, I determined which constellations are the richest per square degree. When adjusted on this scale, the results are different. Most objects per square degree: 0.760 in Crux. (Cygnus is second with 0.471.) Most double stars per square degree: 0.279 Equuleus. (Lacerta ranks second with 0.274.) Most variable stars per square degree: 0.292 in Crux. (Sagitta is second with 0.188.) Most deep-sky objects per square degree: 0.176 Coma berenices. (Virgo is a close second with 0.169).

The exact numbers may be slightly off, since I didn't go back and recount to double check my results. By the way, the constellation with the least number of objects per square degree is Hydrus with 0.074.

While I realize this list has no practical value for observing, it was fun to do and makes for good browsing on cloudy nights.

Daniel M. Hudak
3444 Bentwillow Lane
Youngstown, OH 44511

Unjust Review

Dear Dave / I just finished reading my winter 1986 issue of *Deep Sky* and enjoyed it as always. However, you are somewhat out of line in your review section. Ron Morales' book is a useful book, especially to inexperienced deep-sky observers like myself.

Dave, you are an expert in your field, but not everyone can be an expert. I find astronomy to be a fascinating pursuit, *when* I find time to enjoy it, which is a few times per year!

Ron's book did not fit into the category of *Sky Atlas 2000.0*. But, as was the

case with Little's astrophotography book, it fills a gap that seems to have been ignored.

Please try to keep this in mind the next time you review something that isn't "absolutely wonderful."

Ben Funk, Jr.
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New Brunswick, NJ 08906

Interpreting Velocities in the NGC 7331 Field

Dear Dave / The article "NGC 7331 and Its Ambiguous Galaxies" by Jeffrey Corder and Steven Gottlieb sets us straight on the correct identifications of several of the NGC objects in the vicinity of NGC 7331. It also allows us to avoid the embarrassment of attempting to identify certain objects as galaxies or nebulae when they are in fact stars. The authors remark that "modern observations support the likelihood of a true galaxy cluster in the background, but NGC 7331 is probably not involved." It is interesting to check the radial velocities of some of these galaxies, by which we can judge their distances, from a paper titled "The Radial Velocities of Galaxies near NGC 7331" by C. R. Lynds. The paper appears in *External Galaxies and Quasi-Stellar Objects*, International Astronomical Union Symposium No. 44 (1972, David Evans, ed.).

Galaxy	Radical velocity	Implied distance (H_0=75 km/sec/Mpc)
NGC 7331	826 km/sec	11 Mpc
NGC 7335	6300 km/sec	84 Mpc
NGC 7336	8800 km/sec	117 Mpc
NGC 7337	6900 km/sec	92 Mpc

Seven arcminutes east of NGC 7331 (seven centimeters on the photo on page 14 of Corder and Gottlieb's article) is NGC 7340, which has a radial velocity of 6400 km/sec (85 Mpc). An anonymous galaxy 8' (8 cm on photo) northwest of NGC 7331 has a radial velocity of 8400 km/sec (112 Mpc). An anonymous galaxy 11.5' (11.5 cm on photo) northwest of NGC 7331 has a radial velocity of 8200 km/sec (109 Mpc).

The famous galaxy group Stephan's Quintet lies at the top right hand corner of the photograph on page 15. The largest galaxy in this group, NGC 7320, has a radial velocity of 800 km/sec (10 Mpc), while the other four have radial velocities of 6700 km/sec (89 Mpc), 5700 km/sec (76 Mpc), 6700 km/sec, and 6700 km/sec. These disparate velocities have been cited by Halton Arp as an example of a case where radial velocities could not be interpreted as gauging distances in terms of Hubble's Law, since Arp has maintained that all five members lie at approximately the same distance.

A faint galaxy lies 4' (4 cm) east-northeast of NGC 7320, and it has a radial velocity of 6000 km/sec (80 Mpc). This may be a true member of the Stephan's Quintet group. Another faint galaxy lies 18' east of NGC 7320 (close to a relatively bright star on the southern edge of the photo, partly obscured by a white streak on the photo) and has a radial velocity of 6200 km/sec (82 Mpc). A faint galaxy lies 3.5' (3.5 cm) northwest of the center of NGC 7331, for which Lynds does not give a velocity.

Listing these radial velocities in ascending order, we get 800, 826, 5700, 6000, 6300, 6400, 6700, 6700, 6900, 8200, 8400, and 8800. There can be no doubt NGC 7320 is at approximately the same distance as NGC 7331, but the others must be much farther away. These numbers offer a hint that perhaps the other eleven galaxies fall into two groups.

It is probable the non-NGC galaxies with radial velocities in the 8000+ km/sec range discussed above are too faint to be visible in amateur telescopes, but nevertheless it is sobering to contemplate that, assuming a value for the Hubble constant of 75 km/sec/Mpc, they have a distance of approximately 100 Mpc. And even the lesser members of Stephan's Quintet, which are visible in many amateur telescopes, lie at a distance of approximately 82 Mpc.

Steve writes me that NGC 7336 (8000 km/sec) and the anonymous galaxy 11.5 arc minutes NW of NGC 7331, item 4 above, cataloged by Zwicky as 514.066 (8400 km/sec), have reported magnitudes of 15.9 and 15.7 respectively, and contrary to my speculation that they would be beyond the visual reach of amateurs' telescope, he has observed them with a 17.5 inch in the Sierra. What an eye, What a sky!

K. Alexander Brownlee
Box 127
Ouray, CO 81427

More on Maffei 1

Dear Dave / In *Deep Sky #9*, Chris Schur reported on a sighting of the unusual galaxy Maffei 1 with his 16-inch Newtonian. In the same issue, in an article entitled "Twenty-One Exotic Deep-Sky Objects," you mention that Maffei 1 is beyond the limits of backyard instruments for visual observing and gave a peak surface brightness of 19.6 magnitudes per arcminute!

Although Maffei 1 has been on my observing log since that article was published, I finally took a look at the area on November 30, 1986, with my 13.1-inch scope under the dark sky east of Mount Hamilton. At 62x, I immediately noticed a hazy patch of light with several stars superimposed on it. Careful viewing at 79x revealed a very diffuse, elongated object without central condensation. A small trapezoid of stars

On February 24 UT, the same night Ian Shelton discovered his supernova in the Large Magellanic Cloud, Australian amateur astronomer Robert Evans spotted an out-of-place star in the galaxy NGC 5850. The object was confirmed three nights later by Evans, Gregg Thompson, and Robert McNaught and announced in Marsden's IAU Circular #4321. Early in March Ronald Royer made this photo of the supernova using an 18-inch f/7 telescope, 098 emulsion, and a 30-minute exposure.

is superimposed on the northwestern side of the fuzzy patch. Locating Maffei 1 was relatively easy, since it lies 14' south-southwest of Σ277, a double star with magnitude 7.6 and 10.9 components some 3" apart. I would expect a 10-inch telescope to show the galaxy under a very dark sky.

A few days after observing Maffei 1, I examined its photographed image on the Palomar Observatory *Sky Survey* (POSS) prints at the University of California at Berkeley. I was shocked to find that no trace of the galaxy was visible on the blue print! This explains how Maffei 1 was missed on all of the galaxy surveys based on the POSS and awaited an infrared survey in 1967 by the Italian astronomer Paolo Maffei to be discovered. A check on the red sensitive plate clearly shows this galaxy, but at first glance it appears to be an outlying knot of nebulosity from the giant emission complex IC 1805. I suspect Maffei 1 is simply the brightest of many galaxies in this region of sky so heavily reddened by the Milky Way that many of them have so far eluded detection.

Steve Gottlieb
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Going After the Faint Ones

Dear Dave / I recently completed a 17.5-inch f/4.5 Dobsonian (with enhanced coatings) to compliment my new country lake home under the dark skies of central Minnesota. Having been a devoted reader of *Deep Sky* for several years now, I decided to "test drive" this instrument to see just what it could do. I selected many difficult objects that are often referred to in your magazine.

On my first clear, dark night, I found observing the North America Nebula complex to be easy, including the nearby Pelican Nebula. I then set my sights on the small emission nebula IC 5075 in Cygnus. With the aid of my UHC filter, this nebula appeared as a small, soft glow surrounding a 6th-magnitude star. On the same night I observed Stephan's Quintet, the Bubble Nebula in Cepheus, and just glimpsed the central star in the Ring Nebula with a 9mm Nagler eyepiece and a Barlow lens. I decided to plan a more difficult agenda and waited for the next clear night.

Six days later I got my chance. After dark-adapting my eyes, I began the session with the Horsehead Nebula. With the aid of an Hβ filter, spotting the small Horsehead wasn't difficult at all. In fact, I could see the entire Horsehead shape superimposed in front of the nebula IC 434, rather than a dark patch with no real design.

I finished off that session by observing three faint emission nebulae in Auriga and two in Gemini, IC 405 and IC 410 in Auriga were not difficult to see with a UHC filter. However, IC 417, also in Auriga, was very faint and much more challenging. I finally succeeded in spotting it by falling back on the Hβ filter. That was the most difficult object I saw on the second night.

I then moved south to IC 444 in Gemini. It appeared similar to NGC 2023 in Orion but slightly fainter. Finally, I saw IC 443: it resembeld a miniature version of the NGC 6992-5 part of the Veil Nebula in Cygnus.

Two nights later I shifted my attention northward to hunt for the faint galaxy Maffei 1. This object intrigued me ever since reading about it in "Observing Low Surface Brightness Objects, part 2" in *Deep Sky #7*. Before going out to observe I had carefully plotted its position on my *Sky Atlas 2000.0* using the graduated overlay. I quickly located the region, as there is a 6th-magnitude double star nearby. I ran across Maffei 1 while carefully scanning the area. It appears as a very dim glow around a small grouping of 12th and 13th-magnitude stars. It reminded me very much of the Cocoon Nebula in Cepheus, which I had seen on many occasions. In fact, if I didn't know better I would have thought that Maffei 1 was a faint emission nebula. The galaxy appeared also exactly as depicted in Chris Schur's sketch in *Deep Sky #9*.

It is my impression that the difficulty of observing Maffei 1 has been seriously exaggerated. I believe this because when I was drawing the galaxy an amazing display of Aurora Borealis lit up the entire northern sky almost as far south as Cassiopeia, yet the galaxy remained in view. I encourage everyone with a 10-inch or larger telescope to try spotting Maffei 1.

Patrick W. Drigans
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Sighting Faint Nebulae

Dear Mr. Eicher / The article on photographing the Milky Way in the winter 1986 *Deep Sky* gives the wrong NGC numbers for the eastern part of the Veil Nebula. Although it is usually listed as NGC 6992-5, only the first and last numbers apply to the nebula. The RNGC lists 6993 as nonexistent and 6994 as the little cluster better known as M73.

Although I have never read a report of someone observing it, another object pictured in this article can be seen visually. NGC 7822 and the brighter nebula to its south, Cederblad 214, can be spotted with my 10-inch f/6 scope and a UHC filter. NGC 7822 is visible as a faint brightening off the field, and a couple bright wisps stand out fairly well. Ced 214 consists of a couple of bright patches of nebulosity, just to the north of which is the bright cluster Berkeley 59. This group of stars is best viewed without the filter, as is NGC 7762, another nearby group.

Although you have reported a sighting in a 17.5-inch scope, you might be interested to know that Maffei 1 can be seen in a 10-incher. I observed it several times this winter and have heard reports from two friends who have also seen it in a 10-inch scope. As with many faint objects, visibility seems to be as dependent on sky conditions as telescope size. It would not surprise me if, under the best conditions, it could be seen in a 6-inch scope.

Keep up the good work with *Deep Sky*.

Max Paul Radloff
894 Dodd Road
West St. Paul, MN 55118

Observing Detail in the Eskimo Nebula

Dear Dave / After observing esoteric planetary nebulae for some time, I was quite shocked the other night to discover the amazing detail in NGC 2392, the Eskimo Nebula. It seems that striving for meager detail in faint and small objects trains one perfectly for dissecting the brighter ones.

I was pleased that I could easily detect the dark annulus separating the bright, inner disk from the fainter, outer shell. As it was near the end of an observing session with invading clouds, I decided to push things and use my OIII filter at 255x on my 12.5-inch Dobsonian. Surprise! The dark annulus disappeared, leaving just a jump in brightness from the now more obvious outer shell to the brighter disk. Moreover, right in the center was a darker hole! With the OIII filter preventing the central star from shining through, the hole was fairly evident. This was confirmed by Paul Brown, who was observing nearby at the time.

Although I knew from the picture in *Burnham's* that the bright disk was mottled, I never expected to see this detail, especially as the object glides through the field without a drive on my Dob. Lord Rosse, with his 6-foot reflector, discovered this hole north preceding the central star. It will be interesting to see where this hole lies relative to the central star by using a wider bandpass filter like the UHC. I suspect this hole can be seen in a 10-inch and possibly an 8-inch scope.

I really enjoyed the northern Milky Way photos in the winter *DSM*. The wide field makes them suitable for finder charts. Keep up the good work.

Alister Ling
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Don Mills, Ontario
Canada M3C 1A7

Observing Interacting GALAXIES

by Alan Goldstein

Imagine standing out beneath the sparkling spring sky, ready for another warm observing season. You are scanning near the handle of the Big Dipper, and you come across a pair of fuzzy patches almost in contact. You just glimpse a hint of arm structure in the larger patch, and that one arm appears to touch the second misty spot.

This scene is familiar to all observers who have ever looked at the bright and well-known galaxy M51 in Canes Venatici, the most famous of the interacting galaxies. M51 is better known by its nickname the "Whirlpool Galaxy." When viewed with a large telescope under a dark sky, the Whirlpool is one of the most stunning of all deep-sky objects. However, most observers may be a surprised that fifteen other interacting systems lie within a 20° radius of M51 and are visible in backyard telescopes.

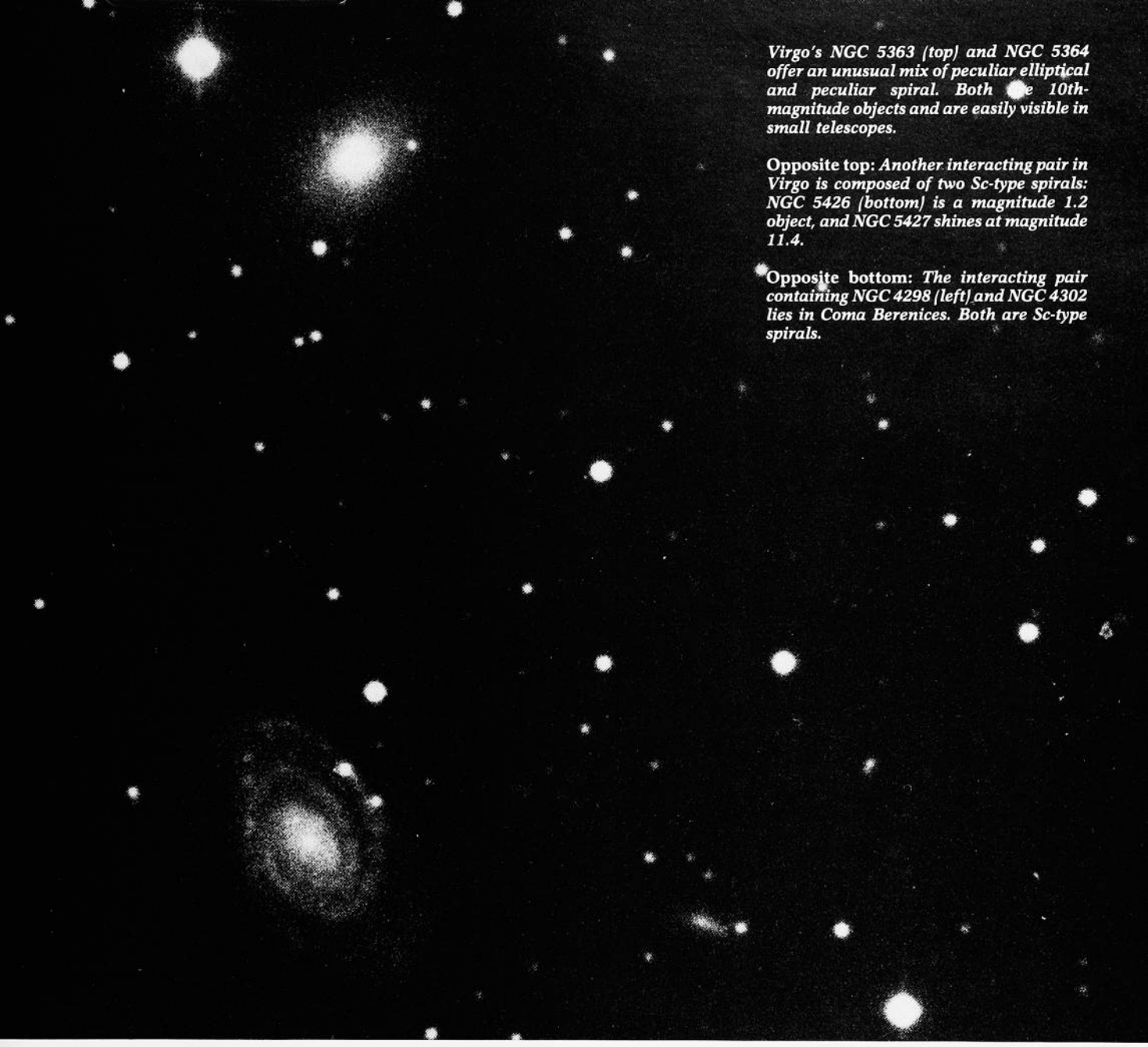
What is an interacting galaxy? It is a galaxy influenced significantly by the gravitational pull of another galaxy. This gravitational attraction may be rather one-sided, when a large galaxy interacts with a small galaxy, for instance, or it can be an equal relationship between two similar galactic systems.

Every type of galaxy is vulnerable to interaction with others that pass nearby. The most common pairs of interacting galaxies seem to be ellipticals with ellipticals and ellipticals with spirals, followed by spirals with spirals, spirals with irregulars, ellipticals with irregulars, and irregulars with irregulars. Even the two best-known galaxies, the Milky Way and the Andromeda Galaxy, are both interacting: The Milky Way with both the Large and Small Magellanic Clouds, and the Andromeda Galaxy with M32.

Interacting galaxies are perhaps most common in rich, dense clusters of galaxies. Some groups of galaxies, like the Hercules, Coma Berenices, and Coma/-Virgo clusters, each have a dozen or more interacting members. Some theorists in the evolution of galaxies propose that lenticular (S0) galaxies are created by frequently interacting spirals which cause a loss of gas. Galaxies have been found in various stages of lenticular-to-spiral transition, which supports this theory. And unusually high number of lenticulars — and low number of spirals — have been found near the centers of rich clusters, where interaction is likely to occur often. Other hypotheses include the contention that galaxy interactions help create the spiral arms in galaxies. This may explain why M51 has such a strongly-defined arm pattern, but it doesn't explain why many spirals are completely isolated.

Interacting galaxies produce an infinite number of results. Some of these, such as connecting clouds of neutral hydrogen, are observable only with radio telescopes. Other features include asymmetric arms, tails and bridges of matter, and odd diffuse haloes of gas. The most bizarre feature is produced when a small elliptical galaxy passes through a larger spiral galaxy, leaving a ring galaxy in its wake. (Unfortunately, there are no ring galaxies

M51 in Canes Venatici is the sky's brightest example of two galaxies clearly interacting. All photographs in this article are by K. Alexander Brownlee and were made with a 16-inch f/5 reflector.



Virgo's NGC 5363 (top) and NGC 5364 offer an unusual mix of peculiar elliptical and peculiar spiral. Both are 10th-magnitude objects and are easily visible in small telescopes.

Opposite top: *Another interacting pair in Virgo is composed of two Sc-type spirals: NGC 5426 (bottom) is a magnitude 1.2 object, and NGC 5427 shines at magnitude 11.4.*

Opposite bottom: *The interacting pair containing NGC 4298 (left) and NGC 4302 lies in Coma Berenices. Both are Sc-type spirals.*

brighter than magnitude 13.5)

Observing Techniques

Observing interacting galaxies can be a challenge, though it does not require more skills than observing run-of-the-mill faint galaxies does. The difficulty in observing interacting pairs really hinges on the brightness difference between galaxies, the shapes of the objects, and the separation between the objects.

Sketching interacting galaxies can be useful for recording your observations. Over a period of time it will allow you to compare different types of interacting galaxies and to maintain a record of observations you can refer back to. If you do not want to sketch deep-sky objects, at least write a short paragraph describing the appearances of the objects.

With a large telescope, 12-inches or more in aperture, you can observing some very challenging interacting galaxies. Try to observe connecting bridges, bright and dark patches near the point of contact, and other features. Large scopes also offer sheer numbers: with an 8-inch instrument you may observe some fifty interacting pairs, but with a 12.5-incher the list grows to 150.

Selected Galaxies

The following list is a guide to fourteen of the best interacting galaxy pairs, though it is not exhaustive even for small telescopes.

NGC 750 and **NGC 751**; designation = Arp 166, VV 189. These galaxies form an interacting pair in Triangulum, not far from the pinwheel galaxy M33. NGC 750 is a magnitude 12.2 elliptical measuring 1.6′ by 1.3′; NGC 751 is a magnitude 12.5 peculiar elliptical measuring 1.3′ by 1.3′. (All coordinates in this article are for epoch 2000.0.) This is a faint but interesting pair of ellipticals with outer envelopes of nebulosity in contact. You'll probably need a 12.5-inch scope to see this pair well.

NGC 3166 and **NGC 3169**. This pair in Sextans is composed of NGC 3166, a magnitude 10.6 barred spiral spanning 5.2′ by 2.7′, and NGC 3169, a magnitude 10.5 spiral measuring 4.8′ by 3.2′. These galaxies are not visually in direct contact but lie close enough to each-other that they're considered interacting. NGC 3169 shows some apparent disturbances from the gravitational tug of NGC 3166. This pair is easy to spot in a 6-inch scope because it appears as a double elliptical patch of nebulosity.

NGC 3226 and **NGC 3227**; designation = Arp 94, VV 209. One of Leo's finest galaxy pairs consists of NGC 3226, a magnitude 11.4 elliptical some

2.8′ by 2.5′ across, and NGC 3227, a magnitude 10.8 spiral measuring 5.6′ by 4.0′. NGC 3227 is a Seyfert galaxy, and its stellar nucleus is visible in large backyard scopes. In a 6-inch instrument this pair appears as two oval patches lying nearly in contact. An 8-inch scope shows a hint of nuclear brightening.

M105, **NGC 3384**, and **NGC 3389**. Leo's M105 trio contains M105, a magnitude 9.3 elliptical measuring 4.5′ by 4.0′, and two fainter galaxies: NGC 3384, a magnitude 10.0 elliptical measuring 5.9′ by 2.6′, and NGC 3389, a magnitude 11.8 spiral some 2.7′ by 1.5′ across. In photographs none of these galaxies appears very disturbed, with the possible exception of the spiral. A 6-inch scope shows all three galaxies, though the spiral requires an 8-incher to be seen well.

NGC 3395 and **NGC 3396**; designation = Arp 270, VV 246. Located in Leo Minor, this little-observed pair contains NGC 3395, a magnitude 12.1 spiral some 1.9′ by 1.2′ across, and NGC 3396, a magnitude 12.2 peculiar galaxy measuring 2.8′ by 1.2′. While these two galaxies are both faint and small, they form one of the best examples of an interacting galaxy pair. Not only are both spirals in direct visual contact, but their mutual interaction causes both to become distorted. An 8-inch scope shows this pair as two galaxies in contact, aligned at right angles to each other.

NGC 4298 and **NGC 4302**. One of the best interacting pairs in Coma Berenices is formed by NGC 4298, a magnitude 11.4 spiral some 3.2′ by 1.9′ across, and NGC 4302, a magnitude 11.6 edge-on spiral measuring 5.2′ by 1.1′. Using an 8-inch scope on a dark night, I only suspected NGC 4302. A 16-inch scope, on the other hand, will easily show 4302 and may even reveal its razor-thin dust lane.

NGC 4435 and **NGC 4438**; designation = Arp 120, VV 188. A splendid interacting pair in Virgo holds NGC 4435, a magnitude 10.9 elliptical some 3.0′ by 1.9′ across, and NGC 4438, a magnitude 10.1 spiral covering 9.3′ by

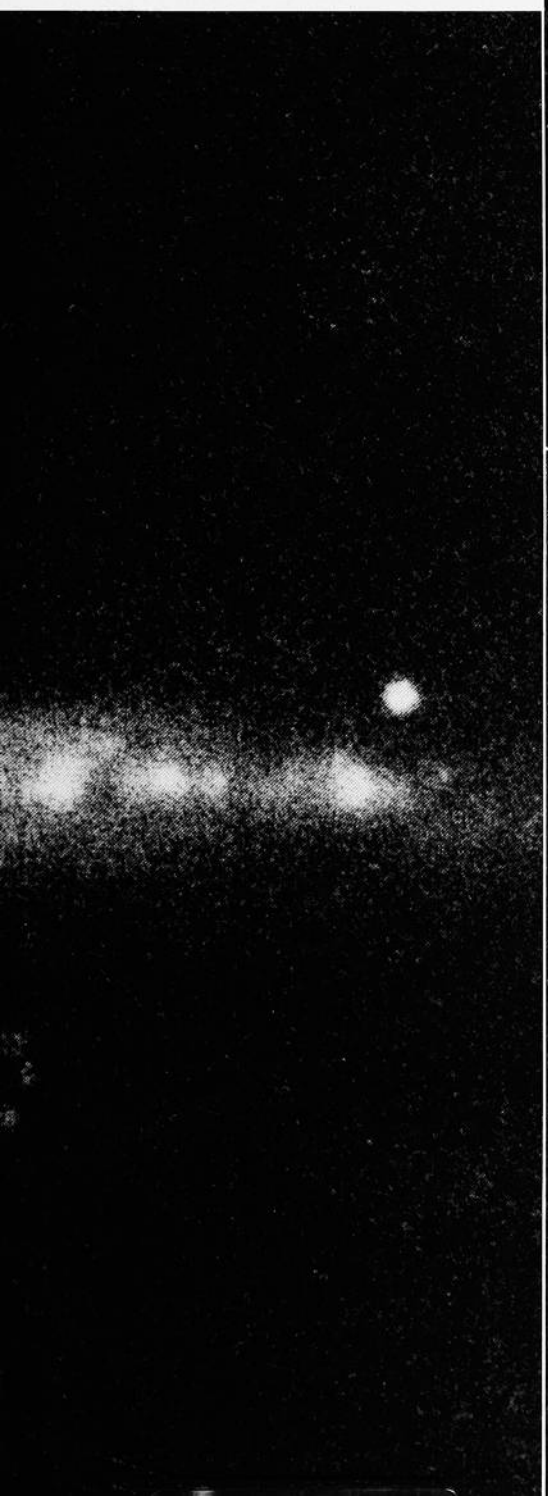
At magnitude 9.3, the edge-on Sc-type spiral NGC 4631 is one of the finest galaxies in Canes Venatici. The galaxy's little companion NGC 4627, however, may require a 10-inch or larger telescope for successful viewing.

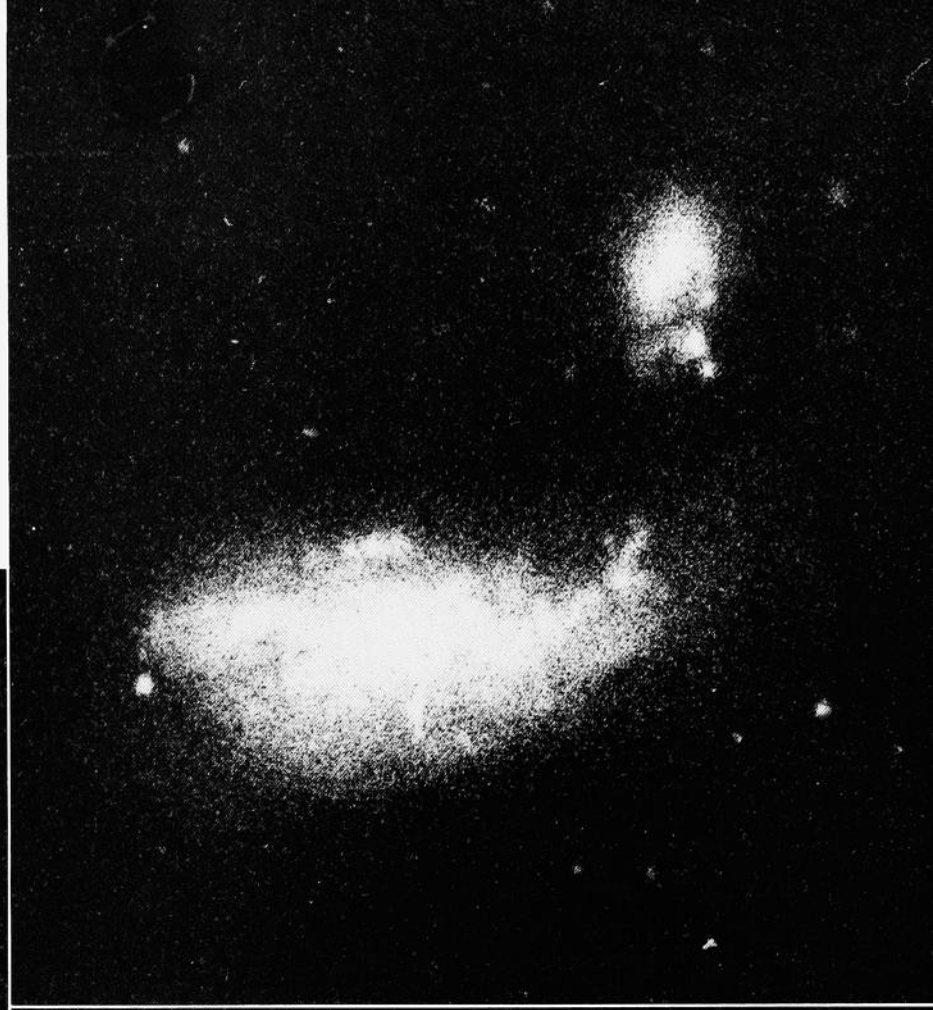
Opposite top: ***Also in Canes Venatici is the bizarre pair formed by NGC 4485 (top), a tiny irregular galaxy, and NGC 4490, a distorted Sc-type spiral.***

Opposite bottom: ***Yet another pair in Canes Venatici holds NGC 5394 (bottom), a warped barred spiral, and NGC 5395, an Sb-type galaxy.***

3.9′. A member of the Virgo Cluster of galaxies, this pair is easy to spot with a small telescope. NGC 4438 is highly inclined but disturbed by the elliptical, so it is not very thin. Most backyard telescopes show, only the central portions of the spiral because the arms have a very low surface brightness.

NGC 4485 and **NGC 4490**; designation = 3C 272, Arp 269, VV 30. Canes Venatici contains a fabulous interacting pair containing NGC 4485, a magnitude 12.0 irregular spanning 2.4′ by 1.7′, and NGC 4490, a magnitude 9.8 spiral measuring 5.9′ by 3.1′. This duo can be observed with a 4-inch scope under a dark sky. With an 8-inch instrument I have observed mottled brightening in





NGC 4490, which appears as a bar-shaped mass of gray nebulosity. NGC 4485 is a tiny patch of light without detail. The pair lies less than 1° northwest of the bright star Beta (β) Canum Venaticorum.

NGC 4627 and **NGC 4631**; designation = Arp 281. Also lying in Canes Venatici is the pair composed of NGC 4627, a magnitude 12.3 peculiar elliptical measuring 2.7′ by 2.0′, and NGC 4631, a magnitude 9.3 spiral covering 15.1′ by 3.3′. The largest galaxy in Canes Venatici is NGC 4631, and it is visible as a bright, thin ray in any small telescope. Under a dark sky the dwarf elliptical companion can be glimpsed as a tiny fuzzy patch in a 6-inch scope.

M60 and **NGC 4647**; designation = Arp 116, VV 206. A fine interacting pair in Virgo contains M60, a magnitude 8.8 elliptical measuring 7.2′ by 6.2′, and NGC 4647, a magnitude 11.4 spiral measuring 3.0′ by 2.5′. M60 is a giant elliptical galaxy in the Virgo Cluster and one of the brightest galaxies in Messier's catalogue. Messier missed the face-on spiral NGC 4647, a faint object that appears like a misty patch of light in a 6-inch scope.

NGC 4752 and **NGC 4762**. Virgo contains another fine interacting pair in NGC 4752, a magnitude 10.6 barred spiral measuring 4.7′ by 2.6′, and NGC 4762, a magnitude 10.2 barred spiral spanning 8.7′ by 1.6′. NGC 4754 appears as an evenly-illuminated oval patch; 4′ south of this object is 4762, one of the thinnest galaxies in the northern sky. In small telescopes its silvery needle of light is quite spectacular.

M51 and **NGC 5195**. The king of the interacting galaxies is M51 in Canes Venatici, one of the brightest galaxies in the sky. In small telescopes M51 appears as a double patch of nebulosity because a small companion galaxy, NGC-5195, is connected to M51 by one of the large spiral's arms. M51 is an Sc-type spiral glowing at magnitude 8.4 and measuring 11.0′ by 7.8′. NGC-5195 is a magnitude 9.6 peculiar galaxy some 5.4′ by 4.3′ in extent. With a large backyard telescope the view of M51 is breathtaking: a 21-inch shows it with prominent spiral structure and a clearly visible bridge between the two galaxies.

NGC 5363 and **NGC 5364**. Virgo contains a spectacular interacting pair in NGC 5363, a magnitude 10.2 peculiar elliptical galaxy some 4.2′ by 2.7′ across, and NGC 5364, a magnitude 10.4 spiral measuring 7.1′ by 5.0′. NGC 5363 appears as a bright round patch of nebulosity; the spiral is a bright, large, dish-shaped oval of light with a bright center and smooth halo of nebulosity.

NGC 5394 and **NGC 5395**; designation = Arp 84, VV 48. A challenging interacting galaxy is formed by the galaxies NGC 5394 and NGC 5395 in Canes Venatici. NGC 5394 is a type SB spiral, glowing at magnitude 11.6 and covering 3.1′ by 1.7′. NGC 5395, on the other hand, is a magnitude 13.0 barred spiral measuring a mere 1.9′ by 1.1′. This galaxy appears as a very small, fuzzy spot, while NGC 5394 looks like a much brighter, distinctly oval patch.

NGC 5426 and **NGC 5427**; designation = Arp 271, VV 21. Virgo contains another interesting interacting pair in NGC 5426, a magnitude 12.2 Sc-type spiral some 2.9′ by 1.6′ across, and NGC 5427, an Sc galaxy glowing at magnitude 11.4 and measuring 2.5′ by 2.3′. In 6-inch telescope this pair appears as an elongated dim patch of nebulosity; larger telescopes hint at arm structure in these galaxies.

This list of interacting galaxies is not exhaustive, but it should provide you with some of the sky's best examples of these distant, changing extragalactic wanderers. As you observe these galaxies, keep in mind that the editors of *Deep Sky* look forward to hearing about your observations.

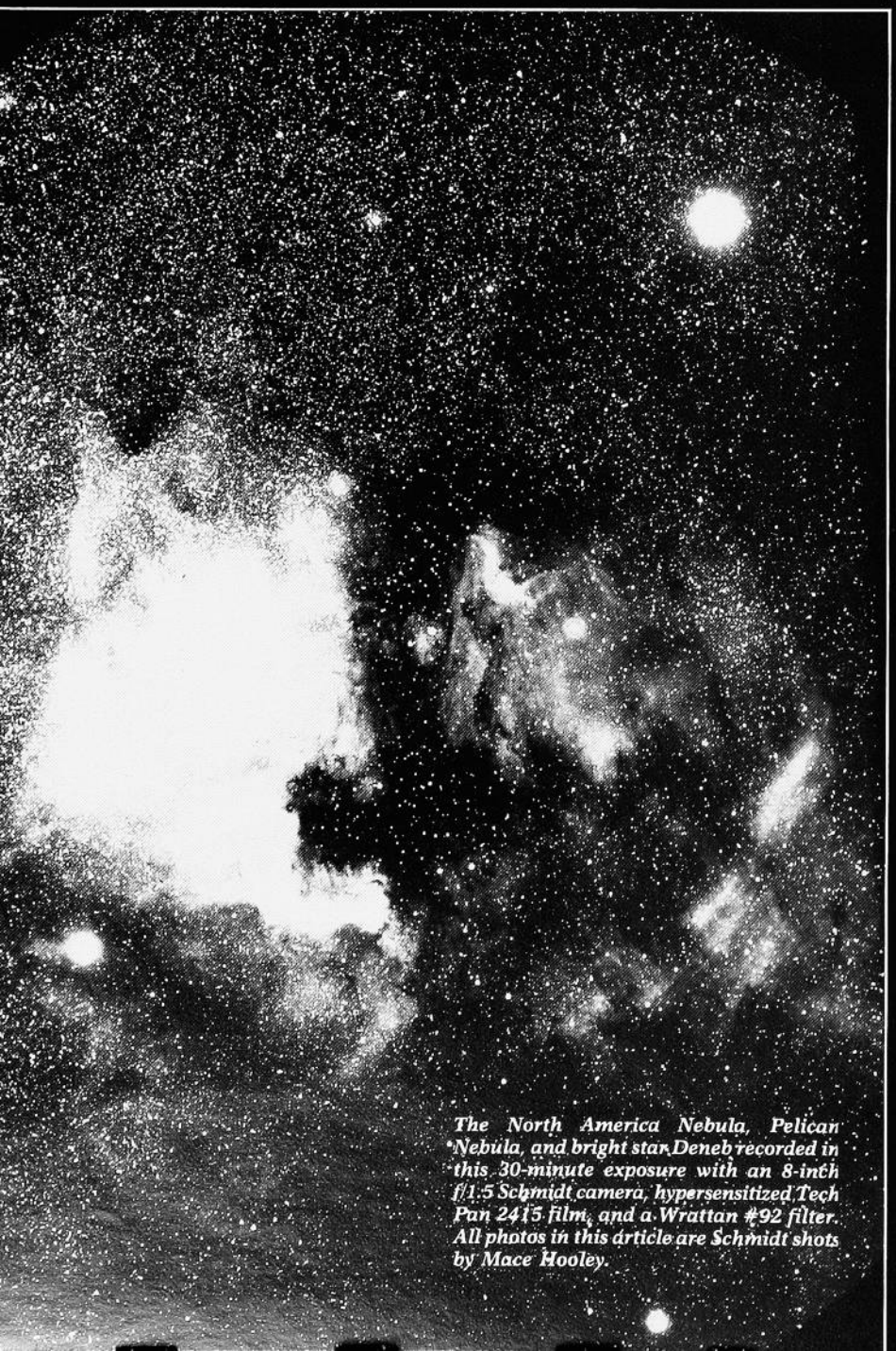
In 1976 Alan Goldstein founded the National Deep Sky Observers Society, the only nationwide group of active deep-sky observers in the United States. One year later he became a contributing editor of Deep Sky Monthly, *and he has contributed many articles to ASTRONOMY as well. This summer Alan will be married; the editors of* Deep Sky *wish him a very happy future.*

Three galaxies dominate this picture: the Sb-spiral NGC 5350 lies at top, while the interacting pair is made up of NGC 5353 (bottom) and the lenticular galaxy NGC 5354.

Opposite: *Leo Minor's contribution to the pool of interacting galaxies is NGC 3395 (top), an Sc-type spiral, and the peculiar galaxy NGC 3396.*

PHOTOGRAPHING Faint DEEP-SKY OBJECTS

by Mace Hooley



The North America Nebula, Pelican Nebula, and bright star Deneb recorded in this 30-minute exposure with an 8-inch f/1.5 Schmidt camera, hypersensitized Tech Pan 2415 film, and a Wrattan #92 filter. All photos in this article are Schmidt shots by Mace Hooley.

Have you ever wondered just how faint a deep-sky object you can capture on film? You've probably seen astounding photographs of Barnard's Loop in Orion or the Lambda (λ) Orionis Nebula, the faint outer extremities of the Eagle Nebula or the low-surface brightness galaxy M33. If you've had experience photographing deep-sky objects, you may have tried shooting these difficult objects before, perhaps becoming frustrated with capturing such tenuous nebulosity. Recording these faint fuzzies on film without some special tricks up your sleeve is difficult.

The key to photographing extremely faint objects is boosting the contrast between nebulosity and sky background to the highest possible level. The way to start this process is with a super film, one with very high speed and lots of contrast.

How should you go about choosing such a film? Based on the spectral signatures of the deep-sky objects you want to photograph. For ruddy emission nebulae, use the spectroscopic films 103a-E and 103a-F, or the ubiquitous Tech Pan 2415. For bluish objects like reflection nebulae and galaxies, on the other hand, you'll want to use IIIa-J or 103a-O, two of Eastman's fast spectroscopic emulsions. All these films maintain their high speeds best when gas hypersensitized.

Whatever your subject, the best method of fighting airglow and gaining contrast is shooting through a filter. With multicolored objects like galaxies or with fields containing both red and blue nebulosity, an interference filter such as the Lumicon Deep Sky filter or other nebular filters will be helpful. For Schmidt cameras with filtered film holders, a gelatin magenta filter will work well; acetate nebular filters are available for Schmidts as well.

For red objects nothing beats a red filter to block airglow and pass the red light virtually unattenuated. The same

Enormous wisps of bright and dark nebulosity coat the sky in the region of the Cone Nebula in Monoceros. This image is a composite of two 35-minute exposures.

Central Orion contains the Horsehead Nebula (right), Barnard's Loop (left), and reflection nebula M78 (upper left), visible amidst fainter nebulosity in this composite of two 37-minute exposures.

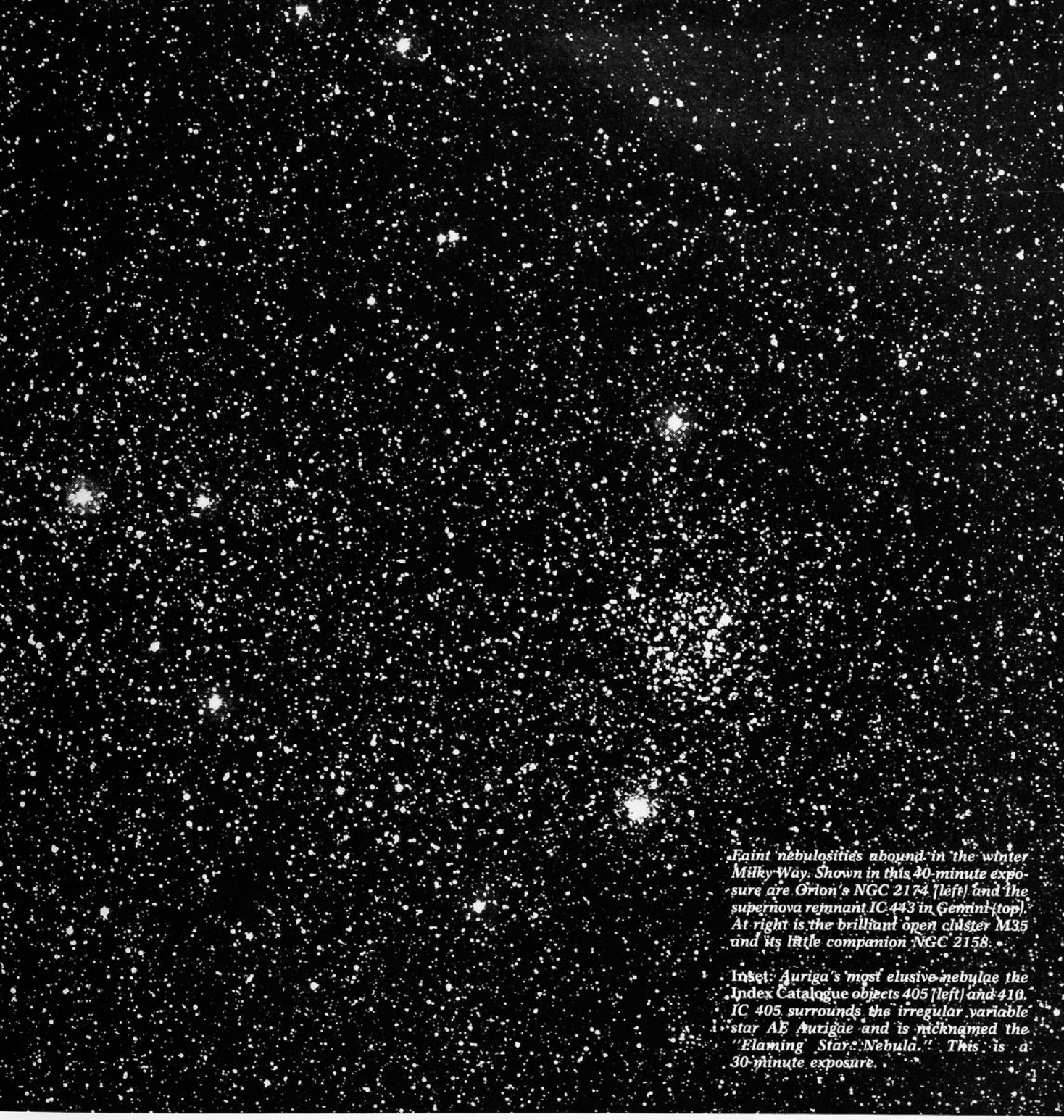
Inset: *A composite of two 30-minute exposures reveals one of the faintest deep-sky objects in the northern sky, the ancient supernova remnant S147 in Taurus. Just 6° away lies a much brighter supernova remnant, the Crab Nebula.*

principle works with blue objects: a light blue filter removes some of the greenish mercury vapor and ionized oxygen airglow.

Exposure times for faint nebulae typically run up to two hours — about twice as long as normal exposure times. With a Schmidt camera, Tech Pan film, and no filtration, an 8-minute exposure suffices, while a 12-minute exposure does well using a 60CC magenta filter. With a deep red filter the exposure time increases to 45 minutes. For blue objects shot without a filter or with a magenta filter, unhypered Plus-X gives great results after a 40-minute exposure.

Telescopically, Tech Pan doesn't reach the sky fog limit until about 30 minutes roll by; with a magenta or nebular filter you can expose for an hour with it, and using a red filter you can go as long as two hours. For blue objects Tech Pan is almost useless, but IIIa-J and 103a-O both work well, even unfiltered. For best results use a light blue filter like Wrattan #80A, or — even better — a deep blue Wrattan #47 filter. For unfiltered blue-light photos expose hypered IIIa-J or 103a-O for 60 minutes; if you use a blue filter, double that time.

Regardless of the film/filter combination you choose, you can achieve only so much contrast between the sky background and the nebulosity. To gain the contrast you really want, you'll need to employ some sort of image enhancement. The most common method is simply duplicating your original negative onto unhypered Tech Pan film, which will yield a contrasty positive with no increase in grain. For extremely low-contrast originals, Eastman's Kodalith lithographic film (available in 35mm and larger sizes and developed in D-19) pulls out very faint



Faint nebulosities abound in the winter Milky Way. Shown in this 40-minute exposure are Orion's NGC 2174 (left) and the supernova remnant IC 443 in Gemini (top). At right is the brilliant open cluster M35 and its little companion NGC 2158.

Inset: *Auriga's most elusive nebulae the Index Catalogue objects 405 (left) and 410. IC 405 surrounds the irregular variable star AE Aurigae and is nicknamed the "Flaming Star Nebula." This is a 30-minute exposure.*

detail, though it's very grainy. Use the highest contrast paper available, typically grade 5 or 6, when making prints directly from the original negatives.

For the faintest nebulosity only composite printing will work. This involves stacking identical negatives in register and making several exposures of the negative sandwich in the darkroom. To do this, cut the individual frames apart and mount them in register inside a glass slide mount. This can be done easily with a light table using a magnifier and clear tape. Tape one negative down by its edges, then tape the second negative on top, moving one side and then the other, until the stars are perfectly aligned. Once all the negatives are registered, snap on the other side of the mount and double-check the registration.

The two sides of the glass mount will hold the negatives together and prevent any smearing of off-axis stars from an enlarger or other noncolinear imaging system.

Several grades' worth of contrast are gained when you use this compositing technique. The method also reduces the apparent graininess of a deep-sky photo, and the grain "smoothes itself out." Resolution is virtually unaffected.

With such lengthy exposure times and complex printing and processing, it's not surprising few amateurs are taking photos of very faint objects. What makes this type of astrophotography so worthwhile is the final result: an image of a gas cloud or a supernova remnant no astronomer — amateur or professional — will ever observe directly.

Mace Hooley is an avid astrophotographer living in Arizona.

Letter to a Beginner

BY DICK SUITER

Photos by Dave Eicher, Walter Scott Houston, and John Sanford.

You've come to me for advice on what telescope to buy and what eyepieces to get. Equipment is certainly important, but I am going to give you some advice on a question no beginner asks, though most should. It may make the difference between becoming a lifetime amateur astronomer and abandoning your telescope in six months to attempt other "hobbies." My advice is: Form an observing group.

Now I realize you may have joined a local club or society already, but merely becoming a member of such an organization does not always lead to immediate satisfaction. After all, a large group of people is understandably an unwieldy body. Generally it moves slowly and not always in the direction you want to go. Nevertheless, I support the concept of an astronomical society because a society brings like-minded people together and can often attempt projects that no single individual could attempt because he lacks the time, the money, or the nonprofit status that attracts donations.

When I say "observing group," however, I am talking about a much smaller number of people, each of whom may or may not belong to the larger astronomical society. You may not consciously acknowledge the existence of the group, but call it a friend or acquaintance instead. The group can and should have fluid boundaries that evolve over time.

Observing is generally something only one person can do directly. Only you can put that image on your retina and interpret the impression with your brain, but much of what constitutes "observing" is indirect. An observer these days must have access to information about telescope design, astrophotography, visual perception, atlases and catalogues of objects, the spectral response of nebular filters, plus assorted miscellanea too numerous to mention. No human being is an expert on all of these things, and it is rare to find the occasional fanatic who knows something about each of them.

Say we have a visual observer who wants to search for supernovae in galaxies. He reasons correctly that some of our own Galaxy's stars might be superimposed upon the galaxies being examined and decides to obtain the location of these stars from published photos. Just as he begins this awesome task, an astrophotographer points out that most published galaxy photos are hopelessly overexposed and that the observer must either chart the positions of stars visually or take underexposed photos with a large aperture telescope. The visual observer manages to convince the astrophotographer to take the underexposed photos. The astrophotographer doesn't know which galaxies to take photos of until he talks to a third observer who points out that backyard telescopes limit the possible visual discovery of supernovae to the nearest one hundred to two hundred galaxies.

Thus, three observers come together and turn an ill-defined idea into a project. Don't these people belong together? An observing group is a necessary outgrowth of an interest in observing. It is difficult to explain what I mean without referring to an example, so I will use my old observing group in Columbus, Ohio, and give you a series of episodes to show you how we have enhanced one another's observing. Although there were many folks in the group over the years, I will deal only with the three people that collectively might be called the group's core.

John Kerns: Skills — good astrophotographer, skilled in deep-sky photography and especially the difficult discipline of planetary photography. Weaknesses — absolutely no knowledge of telescope making or design when I met him (he thought telescopes were "things you buy").

Tom Burns: Skills — rare telescope maker who also enjoys observing. (You would be surprised how rare this is. I've even known telescope makers who bragged they never went observing.) He

1982: Nightfall at Riverside.

has built an award-winning 16-inch telescope, an admired Tri-Schiefspiegler, and is presently working on a 20-inch scope. Weaknesses — knew nothing about mirror-making until he entered our group and is as weak on the scientific aspects of astronomy as you would expect an English teacher to be.

Dick Suiter: Skills — Mirror and telescope maker, binocular observer from age thirteen through college. Amateur optical worker specializing in testing paraboloids and some of the more esoteric things that can help or hurt an image. Weaknesses — tends to be a theorist, solving telescope-making problems on paper rather than building the telescope to try the design. Didn't know anything about astrophotography until he met John.

Episode 1

John Kerns had secured the use of the Schottland 16/24-inch f/2.7 Schmidt camera made by Fecker for a wealthy amateur. It is one of the first Schmidts made commercially in this country and it eventually came into the possession of Ohio State University. People with exceptionally old copies of *Sky and Telescope* (circa 1959) can find this instrument (it is the only one Fecker ever made with a companion 8-inch Schmidt) in the inside front cover. It is also mentioned in King's *History of the Telescope*. The number "16" refers to the aperture in inches; "24" refers to how oversized the mirror was made to avoid vignetting.

A characteristic of these old Schmidt cameras was that you had to refocus them when the temperature changed (unlike modern small Schmidts, in which the focus is held with a temperature-insensitive alloy as a spacer). Proper focus could only be found by taking a photograph on a bright star, bumping the right ascension button and changing the focus micrometer, and taking another short photograph. A series of these photographs taken in the region of suspected focus on a single plate would very likely contain one shot with the proper focus.

These photos were generally made with an out-of-line last star image to aid in identification of the micrometer position. From this John should be able to obtain a series of star images, one of which is distinctly smaller than the rest. This worked in principle, but not in reality. It turned out that there were several star images that appeared to be in equally good focus, and he could not tell if he had focused the instrument properly until he took a long-exposure photograph (all too often he had not). The reason for this was atmospheric turbulence or just instrument vibration.

He brought me this problem, so I reached back into my telescope-making knowledge and dredged forth the Hartmann test. Hartmann screens are normally used to test extremely large telescopes. In my simplified focusing screen two small apertures of about 4 inches were placed at opposite ends of the 16-inch aperture with their separation in the declination direction. The same focusing procedure described above is repeated, the second time with the screen in place.
depicted in the photo on page 00.

Using this technique, John got a much clearer indication of where the focus was, and he could move on to solve the other considerable problems of converting this massive and fickle instrument from glass black-and-white plates to color film photography.

Episode 2

I had a much loved but seldom used 8-inch scope that held my first mirror. It sat idle because I had mounted the instrument on a huge piece of metal that had, for good reason, acquired the nickname "the hernia mount." This

Walter Scott Houston in the 1950s.

Pals Walter Haas and Clyde Tombaugh at the TSP.

Walt Clark and Dave Denbow sight setting circles on the 100-inch Hooker telescope at Mt. Wilson in 1981.

mounting was an excellent one once I had it set up (I could kick the post savagely and not lose the object from the field). Tom was extremely disturbed that this excellent mirror wasn't used more, so he volunteered to make me a Dobsonian mounting. I took him up on his generous offer and had the bad taste to put a couple of conditions on it. I demanded he do nothing that would make converting back to the equatorial mounting difficult. I knew he would do this because of my second condition: that he work exclusively from my design.

You would have to know Tom to know what I was asking. He viewed a telescope as an organism rather than an inanimate configuration of glass and steel. I was asking him to put aside his ideals and work from a design. Luckily for me he decided not to leap snarling for my throat and instead agreed. The resulting instrument has been used more in the past year than in the previous five.

Episode 3

Tom Burns was ecstatic. He had just purchased a new hand-held computer, and he had found a program in a book that calculated altitude and azimuth from right ascension, declination, and the time. Soon he would have his Dobsonians fitted with circles!

The problem was that the program had obviously been written by a non-observer: it demanded inputs in an unfortunate order that caused it to repeat inputs that wouldn't change in the course of a night, and it was only accurate to about a half-degree. This, the program's author informed the reader sagely, was "good enough." A half-degree error compounded with an unavoidable half-degree random pointing accuracy meant Tom would have to search through nine fields of view to find the object. Hardly the performance you would expect from circles.

Tom is not mathematically inclined. Although Tom has a black belt in literary criticism, his mathematical education had an unfortunate gap regarding the Euler transformation, which is required to change right ascension and declination coordinates into altazimuth ones.

I had already written a program for my Hewlett-Packard 41C calculator that does this job, but it hardly helped Tom in view of his recent investment. Besides, whenever I began to talk about the advantages of Reverse Polish Notation calculators, everyone responded with gagging noises (the fools). So John took up the challenge of writing the needed program.

John's program is very user friendly and accurate (it precesses coordinates from another epoch to the present time — you can input 1950 coordinates and get back present day circle readings). It is also written from the point of view of the observer, requires no more input than is necessary, and even does relatively subtle things, such as asking for the time last (this makes a big difference). He has given the program away at several conventions and received many favorable comments.

Episode 4

When John and I first met, the most I knew about astrophotography was that

1982: Jack Marling discusses astrophotography at Riverside.

Richard Berry Leans on a friend at Stellafane.

it involved pointing cameras at the stars. He found a dark-sky site and then began to teach me how to take deep-sky and planetary photos. (Of the two, he rates photographing planets as more difficult than deep-sky objects and even more demanding of patience, which may be the wrong thing to say in a publication devoted to deep-sky observing!) He taught me unwritten techniques for isolating the camera from the main instrument and arranging the telescope itself (it matters). Consequently, we have produced some prize-winning photographs.

Together we learned the technology of baked (60 degrees Celsius) hypersensitizing in 2 percent forming gas. John worked out the hypering times of various emulsions, and I came up with a simple method of evacuating fruit jars for desiccation and storage of hypered films. We also built an astrograph from my design based on what he taught me was important about deep-sky astrophotography. This design works.

Episode 5

Tom Burns had a vacation coming up, and he was moaning over not being able to take his 17.5-inch scope with him.

"But you can," I said.

"How? I'm driving a Toyota."

Then I showed him a picture taken at a Texas Star Party of Thane Bopp's compact 17.5-inch instrument. He snarled and sprang back, forming his fingers into a cross.

"It's got a pipe mount!" he cried, his voice shaking. (Such things are heresy to the followers of Dobson.)

"So? You can make it into a Dobsonian."

Then I sat down and roughed out the design of our "guillotine" telescope right there on top of the photo of Bopp's reflector. Tom took the crude design and in a few weeks added the necessary minutiae to actually produce a working telescope. It was so compact he could easily pack it into his Toyota hatchback. Plenty of room was left to pack lots of camping gear and, incidentally, his long-suffering wife. He took the telescope to the rim of the Grand Canyon and there enjoyed some of the finest deep-sky observing of his life. (This telescope is documented in *Telescope Making #19.*)

Episode 6

We had a 16-inch full-thickness mirror to finish figuring, and the person who had custody of it was moving. We needed a place to work on the mirror. Tom came forward and volunteered his basement for use as a telescope-making workshop. We moved three barrels there to support the 16-inch and to allow several people to work on their own mirror-making projects (as optics prices continue to rise, rolling your own is again becoming attractive). We finished the 16-inch project and made a fine and often-used telescope with it. As far as I know, Tom's basement is still set up for mirror makers. Turn on East Street and listen for the muttering of Susie, his wife.

The Advantages of Forming an Observing Group

The other advantages of forming an observing group are less obvious but no less real. It turns out that dark, out-of-the-way places easily reached by car are popular with small-time drug users and intoxicated riffraff. (The tale is told around Columbus that at just such a location one night some people stopped and shot guns into the darkness for half an hour. The observers, who had several thousand dollars worth of equip-

ment — including an 1870 vintage 4-inch Alvan Clark refractor — bravely held their ground. Finally, apparently bored or beginning to sober up, the riflemen left.) Somehow, you feel safer with some friends around, even they're no more skilled in hand-to-hand street combat than you are.

You will also observe more often. Below is a typical exchange between observers Tom, John, and Dick. We entered this conversation not much inclined toward observing that particular night, but we slowly changed our minds.

T: "Looks like it will be cloudy tonight."

D: "Yeah. It's supposed to be partly cloudy."

J: "But it will be clearing later on." (Here we see one of the prime characteristics of the serious observer — unjustified optimism.)

T: "If it does clear, I definitely want to take out my 4-inch Schmidt-Newtonian and star-test it."

D: "Do you want to go to Alum Creek?" (Alum Creek was our moderately dark-sky site about twenty miles from Columbus.)

T: "Yes."

J: "This would be a good time to try out that new Hβ filter."

D: "But Alum Creek wouldn't be a good place to try for really dim objects."

T: "Want to go to Hocking Hills?" (Referring to our black-sky site about seventy miles away.)

J: "No way! I have to teach tomorrow!"

T: "But it will be clearing from the south. Hocking Hills may be clear and Alum Creek cloudy." (Alas, temptation!)

J: (Hesitates, at which point Tom knows he's won.) "Okay, but just during the evening. At midnight we pull out of there — even if Tom begs."

D: "As long as we're making a production out of it, why don't we take the 16-inch."

J: "I'll take it in my car."

Thus we had talked ourselves out of a cloudy night and into a major expedition that involved hauling a 16-inch telescope over seventy miles. It's not as if we were unaware of what had happened, but we were powerless to prevent it. It resembled a ritual dance of some primitive tribe. We had taken our places and danced our steps, knowing the result before we started. We had performed an act of magic designed to appease the Clear-Sky god.

I obviously approve of observing groups and urge you to form one. But just how large a group should you try to make? You have to trade off the added expertise with the number of social interactions that can (and must) take place. Two people can interact socially in only one way; three people have four possibilities. Once the number exceeds four the number of interactions increases explosively until, by the time you reach six or seven people, you have more of a star party than an observing group. You tend to stand around jabbering instead of observing. Even worse, because of all the talking, large groups are likely to stand around the largest instrument taking a tour of bright Messier objects (not that such nonserious observing isn't a good idea once in a while). It's especially hard on astrophotographers, who must keep their eyes glued to the cross hairs while in the background someone announces he has M15

Welcome to Riverside!

Messrs. Eicher, Bok, and Ellis pose at the Texas Star Party, 1982.

resolved clear across the tight core. Astrophotographers just bite their lips and whimper.

I would advise an observing group of three or four if you want to do serious observing only, five if you are fonder of the social aspect. Actually, formation of an observing group is seldom under the complete control of its members. The process of meeting friends is seldom conscious. I have presented the social interaction argument just so you can understand why a group of six people sometimes gets less done than a group of three. If you are aware of the process, perhaps you can guide it to a small extent.

Naturally, such groups can evolve into cliques if you aren't careful. I believe that if the process of forming groups is consciously thought out, this depressing tendency can be avoided. Invite others along to observe (especially if one person bows out that evening). Observe with others. Avoid the *us* vs. *them* mentality of an exclusive group. Once you become experienced, don't step on beginners' feelings — invite them along too. Everyone, no matter how much of a beginner, will eventually contribute something of value to an observing group. View a beginner as a responsibility to nurture rather than as dead weight around your neck.

If you are a beginner, you might want to form a group of beginners for the purpose of growing together. The presence of a person who has the positions of five hundred objects memorized can sometimes be daunting.

An observing group is capable of doing things one person can do but few people are willing to do, such as setting up major observing expeditions, attending distant conventions, and even loading up a car with observing equipment. Perhaps the greatest benefit of belonging to an observing group is that you can share equipment. Tom borrowed my Foucault tester, I borrowed John's eyepieces, and Tom tended to have more filters than either of us. Such expenditures can even sometimes be coordinated, with one member agreeing to buy a certain eyepiece if another member buys something else. This is safe as long as it is clear who owns the equipment. I think group purchases are a bad idea — they can eventually lead to divisive behavior.

A group can be what you want it to be. It can be a casual group of acquaintances to observe with or close-knit friends you may want to interact with in nonastronomy situations. It can be as deep or as shallow as you like. Some gigantic clubs, I'm told, assign a tiny plot of land at the observing site to an individual. He has little or no choice about who his neighbors are and no chance of changing them. He either accepts his neighbors or he withdraws into a solitary shell. Perhaps because of their sheer size these clubs have been forced into behavior that ignores the microscopic social aspect so crucial to something called a "society" or "club." That's really too bad.

When you really think about it, the advantage of an observing group is the friendship and camaraderie resulting from such an association. No matter how much I benefited astronomically from knowing John Kerns and Tom Burns, the thing I cherish most is their friendship.

Amateur astronomers view the Sun's disk at the Mount Wilson 150-foot solar telescope.

The Swap meet, a prime social activity for stargazers.

Small Scope Showcase

The Clusters of Spring

by David H. Levy

One winter I remember what seemed like endless snow and bone-chilling cold. When the sky finally cleared, I thought Earth had lost track of its orbit, for Leo was suddenly almost overhead. The entire winter sky, full of gas clouds and nebulae, had vanished and was replaced by the constellations of spring, with galaxies everywhere. Expecting gas, I got galaxies instead!

For our sake this year, let's hope for warm, clear weather — quiet starry nights to enjoy with our telescopes. Galaxies and other goodies always seem to be larger, more structured, and generally more appealing on a warm clear night than in the midst of a violent windstorm.

But just in case it's still winter when it's spring, we'll begin in Orion, right below the magnificent nebula **M42** (NGC 1976). You thought the Great Nebula was all there was in Orion, didn't you? Not by a long shot! First, there's **M43** (NGC 1982), a detached portion of M42 lying just to the north and a worthy object all by itself. Then go about 3° northeast of Alnitak (Zeta [ζ] Orionis), the star at the eastern end of Orion's Belt) for **M78** (NGC 2068), yet another diffuse nebula. In a small telescope this object looks cometlike, but don't make a fool of yourself by announcing a "discovery." You can tell nebulae from comets because nebulae don't move — you'd have to wait several million years to see M78's motion!

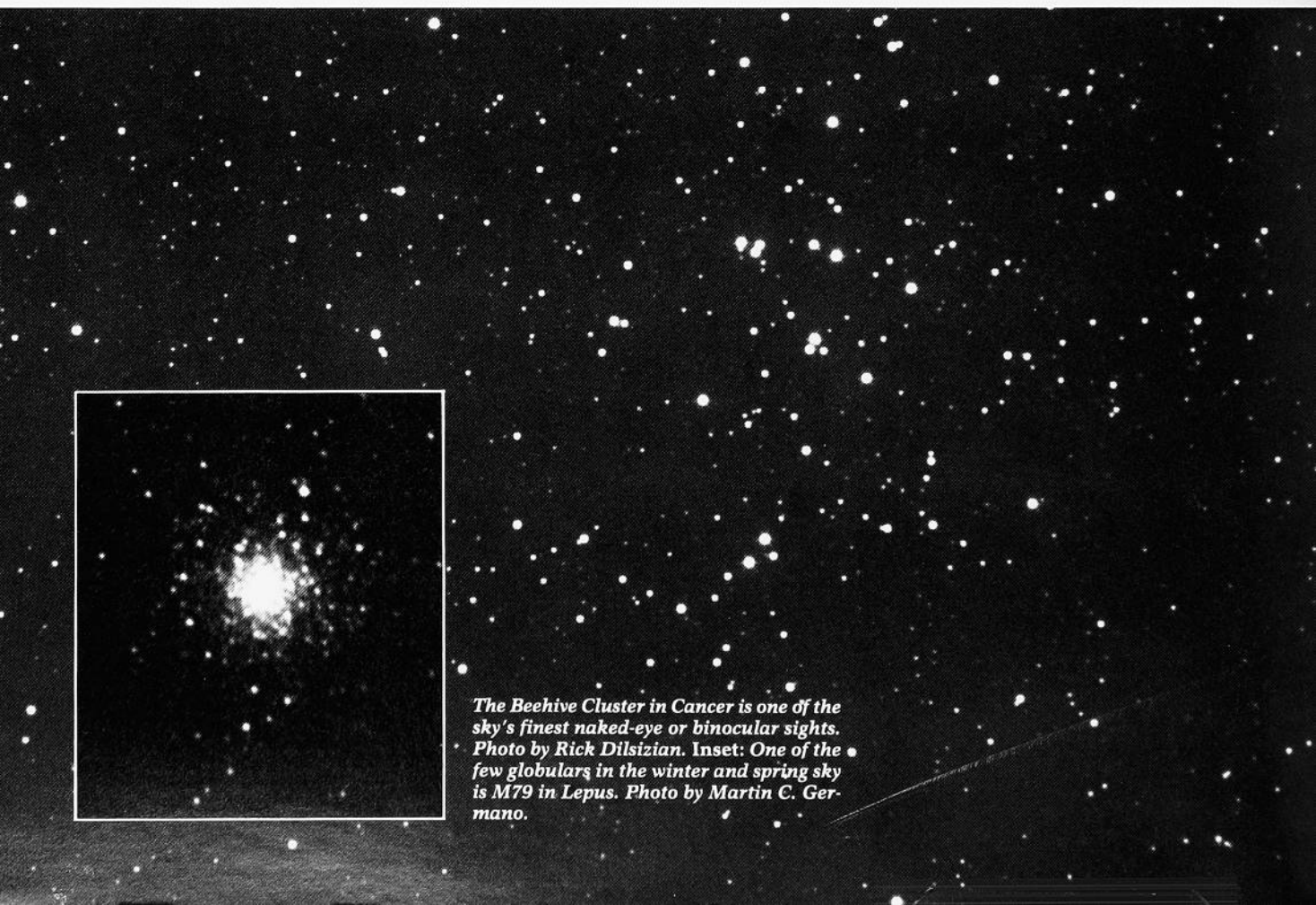
Gemini is still high in the sky at the start of spring, although by the time the weather is warm enough for you to observe it in comfort, you may have missed much of what Gemini offers. Try for **NGC 2392**, the Clown Face or Eskimo Nebula. It is a sharply defined planetary nebula that appears bluish-green. Photos taken with large observatory telescopes show it quite differently — complete with dark splotches that represent eyes, nose, and mouth, and even a ring of fur framing the face!

In Monoceros, just about 6° south of Gamma (γ) Gem, you can treat yourself to a last look at **NGC 2264**, the Christmas Tree Cluster. This cluster is something you really need to view at the first star party your club has in spring. I've learned to call it the "Oh, Yeah!" Cluster, because after a brief look, suddenly the pine-tree shape appears and you exclaim "Oh, yeah!" Nearby (about a degree to the southwest) is **NGC 2261**, Hubble's Variable Nebula, a beautiful cone-shaped structure surrounding the variable star R Monocerotis. Over a number of years this nebula has changed in apparent shape through alternating appearances of light and dark areas.

In this fascinating region of sky star formation is taking place, just as it is in the Orion region. The whole area has delights to look at, but be sure you go out into the countryside away from city lights and take your largest telescope.

By now you may be a little puzzled and asking yourself: "Why doesn't the old boy tell us more about eyepieces, positions, magnitudes, and shoe sizes?"

In fact, the old boy has said little about *any* of the objects for this quarter of the year and would like to keep it that way, thank you. My object is to get you to go outside, find the objects (or fail!), and then make your own notes about



The Beehive Cluster in Cancer is one of the sky's finest naked-eye or binocular sights. Photo by Rick Dilsizian. **Inset:** ***One of the few globulars in the winter and spring sky is M79 in Lepus. Photo by Martin C. Germano.***

The Hercules Cluster is visible as a fuzzy patch of light in binoculars; telescopes resolve it into many stars, which give it the reputation of being the finest globular in the northern sky." Photo by Preston Justis.

what you've seen. This approach is especially important with diffuse nebulae, which are often the most structurally complicated of all deep-sky objects.

With open clusters things are a little more straightforward since the stars in open clusters do not lend themselves to different interpretations by different telescopes in different locations. In Cancer, for example, is M44 (NGC 2631), the Beehive Cluster. In some clusters the stars seem to be arranged in lines or chains, and in others the arrangement appears random — M44 offers triangles. To the unaided eye this cluster looks just diffuse enough to be confused with a faint comet, and over a hundred years ago the great English poet Gerard Manley Hopkins believed he saw a comet. A night later, however, he confirmed that what he saw was the Beehive.

How surprised he'd have been if he had had the chance to visit here in the spring of 1983 when a real comet, looking quite like M44, sped by the huge open cluster! Do you remember the Earth-approaching comet of that year, IRAS-Araki-Alcock?

Actually, Hopkins shouldn't have felt uneasy about his misidentification. I know of one Kitt Peak astronomer who mistook M44 for a brighter-than-predicted Halley last year. And, of course, Charles Messier himself may have confused it for a comet when he gave it the number in his catalogue.

Moving east and deeper into the spring sky, we approach clusters of a different kind. Instead of a few hundreds of stars, the distant globular clusters contain many hundreds of *thousands*. These clusters, whose members are old stars, orbit the Galaxy at distances of tens of thousands of light-years. Most of the sky's globulars are concentrated near the center of the Galaxy, which places them in Sagittarius, now far below the southeastern horizon. Sagittarius has more such clusters than most of us would care to count, but there are a few globulars on the other side of the Galaxy, including a very faint one Clyde Tombaugh discovered during his search for trans-Neptunian planets.

The winter sky has virtually none — though **M79** (NGC 1904) in Lepus is a small, 8th-magnitude cluster about 4° southwest of Beta (β) Lep. In the spring sky, however, globulars are easier to find. M3 in Canes Venatici hovers like an intruder in a region of sky otherwise filled with distant galaxies. Still farther east still come two grand clusters in Hercules — **M13** (NGC 6205) and **M92** (NGC 6341). These clusters beckon irresistibly, and you see more in them with every increase in power. Shorter and shorter focal length eyepieces succeed one another until, finally, the atmospheric seeing breaks down, and the cluster becomes a dim, wiggly smudge.

As the spring months go by, the Hercules clusters climb higher and higher, becoming ever more beautiful. They become easier to see as they get higher because you see them through less turbulence. Turbulence is always present in the atmosphere and is especially noticeable when you observe details at the limit of your vision. Seeing problems occur most often with barely perceptible details on planets, but faint galaxies and nebulae can actually fade below detectability when the seeing is especially bad.

Seeing is not always the same as scintillation — the twinkling effect of stars you see with the unaided eye. On a twinkly night the seeing is usually poor, but seeing can be bad even on nights with almost no twinkling. You just have to go out and discover that for yourself.

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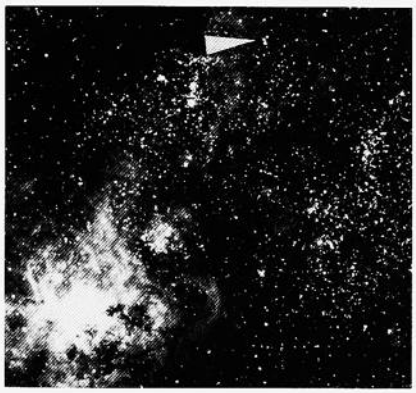
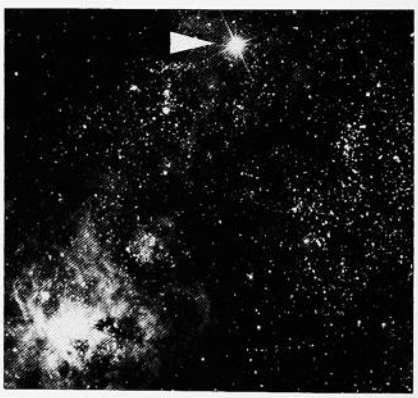
SUPERNOVA IN THE LMC

Since the morning of February 24, the eyes of the astronomy world have centered on one star: the brightest supernova since Kepler's erupted in 1604.





Beginning on February 24.06 UT Canadian astronomer Ian Shelton photographed the Large Magellanic Cloud. As he developed the plate at 24.23 UT, he spotted an out-of-place star glowing at about 5th magnitude and lying only 18′ west and 10′ south of the Tarantula Nebula. After eliminating all other possibilities, Shelton concluded he had discovered a supernova inside the LMC.

This event carries enormous potential for answering all sorts of questions in astrophysics. Because of its proximity at 53 kiloparsecs, the star is being monitored by a much larger number of instruments than typically observe extragalactic supernovae. A considerable collection of data needs to be assembled before astronomers reach any significant conclusions about the event.

At the least, the Type II object is behaving strangely. It brightened rapidly to magnitude 4.5 in a few days and then dimmed slightly and reddened dramatically. By March 28 it had brightened to magnitude 3.96 but was still about two magnitudes fainter than a normal Type II supernova should have been at its distance.

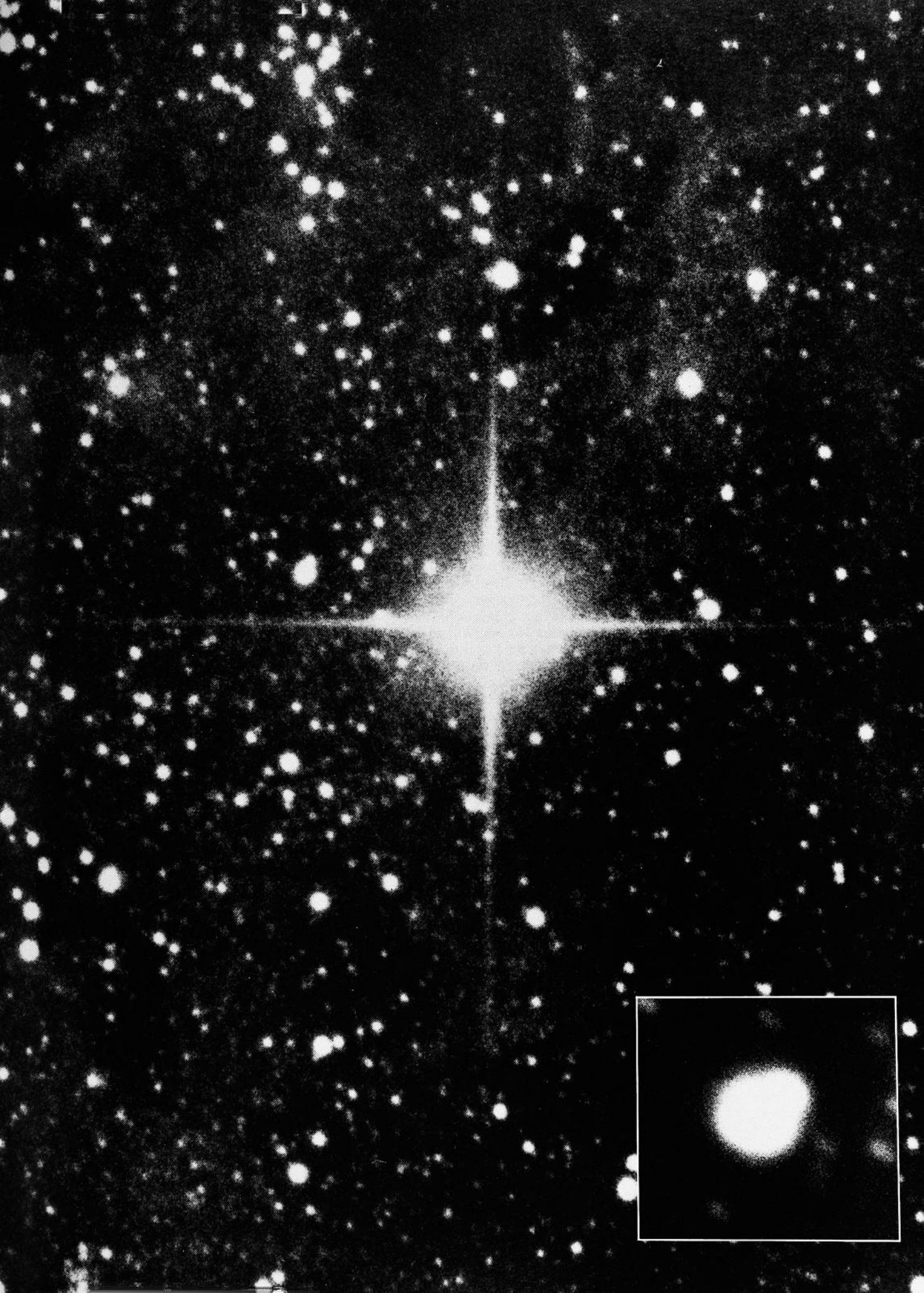
The summer issue of *Deep Sky* will include a full-length review article of the supernova and its implications on the astronomy world. Here we include a sampling of early photographs of the supernova which were made during the first month of the supernova's existence. *David J. Eicher.*

Top: ***Astronomer Wendy Roberts made this wide-field image of supernova 1987A on February 25. Roberts used the Curtis Schmidt telescope at Cerro Tololo Inter-American Observatory in La Serena, Chile. Courtesy National Optical Astronomy Observatories.***

Above: ***This pair of photos shows the LMC with and without the supernova. The photo at left was made in 1969 by V. M. Blanco, who used Cerro Tololo's 1.5-meter telescope. The photo at right was made by Wendy Roberts on February 25, 1987, with the observatory's Curtis Schmidt telescope. Courtesy Robert E. Williams, Cerro Tololo Inter-American Observatory.***

Right: ***The European Southern Observatory's powerful Schmidt telescope in La Silla, Chile, recorded the supernova as a blazing 4th-magnitude star on February 25. Courtesy European Southern Observatory.***

Inset: ***This ESO Schmidt photograph from December 6, 1979, shows the star whose companion is most likely the supernova's progenitor. Courtesy European Southern Observatory.***



Double Stars

Another Crack at Leo

by Brian Skiff and Paul Brown

As guest columnists, we'd like to tell you about some double stars we enjoyed viewing last spring. When Brian undertook this project, he had viewed only a few pairs in a systematic fashion, so he enlisted the help of Paul Brown, who has examined over 1500 doubles. Along with providing corroborating notes on the objects discussed below, he helped Brian get started in less tangible ways.

Most of the Flagstaff observations were made using a 7-inch refractor that serves as the guidescope for the Lowell Observatory "Pluto" camera. The refractor has a fixed eyepiece of about 180x. A few notes were made using a 10-inch refractor guidescope and the Lowell 24-inch Clark refractor. Paul used his 8-inch SCT occasionally fitted with off-axis masks of various smaller apertures. Seventeen objects from a working list of twenty were examined by either or both of us and, in general, these pairs are closer than the Leo doubles discussed by Glenn Chaple in the Spring 1986 issue. Even so, several of them are resolvable in the smallest instruments.

The brightest pair in our selection is also an easy one the well-known double **Gamma (γ) Leonis** (ADS 7724). Paul viewed the star in the 8-inch with a 1-inch stop, where the pair is actually below the Rayleigh limit. The two images were indeed partially merged and far less colorful than at full aperture. The pair consists of two red giants, though they are slightly different in color — the secondary being bluer (or less orange). Paul describes them as yellowish-white and green-yellow. The current orbit (quite uncertain owing to the very long period) shows the pair widening very slowly with an accompanying increase in position angle.

A bright pair on our list that we missed is a close, rather difficult one. In the early 1960s E. J. Hartung in his *Astronomical Objects for Southern Telescopes*, found **Omega (ω) Leonis** (ADS 7390) a test for his 12-inch reflector when the secondary was at 0.44" in p.a. 321°. About the same time John Mallas (of "Messier Album" fame) observed the star in a 4-inch refractor. At 300x he saw a clearly noncircular image that was yellow on one side and bluish on the other. This demonstrates that there is no well-defined resolution limit for any given aperture: the Airy-disk images merely become merged to a greater and greater degree, with the contrast of the optics and the observer's skill determining when the images appear circular rather than oval with a dip in brightness between them. The separation is roughly the same now as it was then, but the companion has whipped around to the northeastern quadrant.

ADS 7704 is an easy pair in moderate apertures. Twenty-five years ago Hartung separated them in 6 inches aperture, while at 4 inches the images were in contact. Both of us saw the position angle clearly as about 180° even though the secondary is only ¼ of a magnitude fainter than the primary (we agree that the Δm is small, however).

ADS 7730 is a nice triple for moderate apertures; at 8 arcseconds, the C component is easy. Brian found the closer AB pair almost continually notched in the 7-inch, while Paul saw clear elongation in the oval image in p.a. 320° at 320x in his 8-inch. The close pair is beginning to show orbital motion (increasing p.a.), and the third star has remained fixed for several decades, suggesting a physical connection.

ADS 7837 (49 Leonis) is relatively easy despite the two-and-a-half magnitude difference between the components. The primary is itself double, forming an eclipsing binary of the Algol type designated TX Leonis. The combined brightness of the whole system changes by only 0.1 magnitude over a 2.4-day interval. Neither of us noted any color (never trust Brian's colors — he has red-deficient vision anyway!) However, Hartung comments that the pair are pale-yellow and white. The binary has remained essentially fixed for 150 years.

ADS 7979 (54 Leonis) is an easy pair for small telescopes. Viewing them in his 8-inch, Paul saw the colors as blue-white and greenish-white. Hartung saw pale-yellow and white. This pair has been measured with a scanning photoelectric photometer that makes use of a narrow slit moved across the pair to observe them individually. These observations show the fainter star to be only 0.08 magnitudes redder in B-V color. This difference is not likely to be noticed visually, so the color contrast must be largely a physiological one, caused by the unequal brightness of the stars. The companion is a spectroscopic binary, so at least three stars are involved in this system.

We both had a difficult time with **ADS 7982** (55 Leonis): neither of us saw certain resolution in 7- and 8-inch telescopes, though Paul noted a slight elongation in the correct position angle. The orbit shows the pair widening only very slightly through the turn of the century, when they reach apastron as well as greatest apparent separation.

ADS 8007 turned out to be much easier than expected and was resolved in Paul's 8-inch at 125x. The WDS catalogue shows the Δm to be 1.6 magnitude, but Brian's observation in the 7-inch suggests this must be an error for 0.6, which he confirmed at the 24-inch Clark. Alas, there are no photoelectric measurements to clear up this ambiguity; we would be pleased to hear from others about this pair.

ADS 8043 poses a different problem, this time with position angle. Paul agrees withe WDS is giving the position angle at about 300°. But on two occasions (7-inch and 24-inch) Brian found the p.a. flipped by 180° to about 120°. This observation agrees that of with French astronomer Paul Couteau, recorded in his book *Observing Visual Double Stars*. Admittedly, the magnitude difference is only 0.1. but it may be that one or both of the stars are variable, which causes apparent p.a. to flip back and forth depending on who's up and who's down in brightness. What do you see?

ADS 8128 is an interesting pair that will gradually become more difficult in the coming decades. Hartung resolved it clearly in just 3 inches aperture twenty-five years ago; a 4- or 5-inch will be required to make the same statement now. Brian found it moderately difficult to resolve in the 7-inch, while Paul reported questionable resolution on two nights in the 8-inch. The somewhat uncertain orbit shows the companion closing to about half an arcsecond after the year 2000.

Brian spent much time at different telescopes attempting to resolve **Iota (ι) Leonis** (ADS 8148). Neither of us caught it the first time in 7- and 8-inch telescopes. A month after his first look Brian tried with a 10-inch refractor, which did show the companion at 240x and 325x sitting between the second and third diffraction rings. A week later he moved to the 24-inch Clark, which showed the pair clearly resolved even when diaphragmed down to just 6 inches aperture. This is in contrast to T. W. Webb's observation a hundred years ago (when the pair were about 2 arcseconds apart), when he found them

Double Stars in Leo

ADS or Other Name	RA (2000)	Dec.	Magnitudes	Sep (")	pa (deg)	date	Spectral Type	Remarks
7390=ω Leo	9h28.5m	+ 9°03′	V=5.9,6.5	0.45	41	(1987)	F9IV	combined V=5.41, B-V=0.60.
Couteau 286	9h58.1m	+20°59′	7.7,10.0	1.1	184	(1975)	F5	not plotted on Tirion: near the Mira variable V Leonis.
7695	10h15.2m	+19°07′	8.8,8.8	2.4	258	(1973)	F2	fixed since 1830.
7704	10h16.3m	+17°44′	V= 7.2,7.5	1.4	183	(1980)	A9IV	combined V=6.59, B-V=0.31.
				1.5	179	(2000)		
7715	10h18.1m	+27°31′	8.3,9.3	4.5	331	(1967)	F2	fixed since 1830.
7724=γ Leo	10h20.0m	+19°50′	V= 2.2,3.4	4.35	124	(1987)	K1⁻IIIbCN-0.5,G7IIICN-1	A comp is a spectroscopic binary. The system is possibly variable with a V amplitude of 0.15 mag. combined V=1.90, B-V=1.15;ΔV=1.15, ΔB-V=-0.28.
				4.41	125	(2000)		
7730	10h20.5m	+ 6°26′	AB: V= 7.9,8.4	0.9	304	(1977)	F5	for AB: combined V=7.36, B-V=0.05.
			ABxC:V= 9.6	7.6	9	(1968)	F5	For C: B-V=0.58.
7744	10h22.7m	+15°21′	V= 7.4,9.5	1.60	249	(1987)	G5	combined V=7.26,B-V=0.66
7837=49 Leo	10h35.0m	+ 8°39′	V= 5.7,8.5	2.2	157	(1975)	A2V	combined V=5.67, B-V=0.05. A comp is Algol-type variable TX Leonis; see text for comments.
7979=54 Leo	10h55.6m	+24°45′	V= 4.5,6.4	6.3	110	(1973)	A1V,A2Vn	B comp is a spectroscopic binary. Combined V=4.32, B-V=0.01; ΔB-V= 1.95,ΔV=0.08.
7982=55 Leo	10h55.7m	+ 0°44′	V= 6.1,8.0	1.08	61	(1987)	F4V	(for A comp only). combined V=5.90,B-V=0.43.
				1.11	58	(1992)		
8007	11h00.0m	− 3°28′	7.5,9.1	1.5	305	(1976)	F8V	
8043	11h04.0m	+ 3°38′	7.8,7.9	1.2	297	(1975)	Am	
8128	11h19.0m	+14°16′	V= 6.9,8.0	1.30	34	(1987)	G0	combined V=6.57,B-V=0.57.
				1.12	37	(1992)		
8148=ι Leo	11h23.9m	+10°32′	V=4.0,6.7	1.34	133	(1986)	F4IV	for A comp only, which is a spectroscopic binary). Combined V=3.94, B-V=0.41; suspected variable.
				1.39	129	(1988)		
8820=90 Leo	11h34.7m	+16°48′	AB:V= 6.3,7.3	3.4	208	(1981)	B4V,B6.	combined V=5.95, B-V=−0.16. B is a spectroscopic binary.
			AC: 8.8v	63.1	234	(1938)		
8263	11h40.6m	+21°02′	8.2,9.7	2.7	349	(1977)	G5	fixed since 1829.
8311	11h48.6m	+14°17′	V= 6.2,8.5	1.02	350	(1980)	A8III	(for A comp only). Combined V=5.88, B-V=0.29.
				1.07	346	(1985)		
				1.10	342	(1990)		

"just divided" at 80x in his 3.7-inch refractor. Couteau notes they are rarely resolved with less than 6 inches, but this obviously depends on what century you live in!

ADS 8311 lies just 17 arcminutes south-southwest of Denebola and provides a test for contrasty optics because of its magnitude difference. Brian could not see the companion in the 7-inch; an early view with the 24-inch showed the companion only with difficulty on a poor night. Later he used the iris diaphragm to view it clearly at 12 inches aperture, though it was visible at 8- and 10-inches as well. The ephemeris given in the table is from a twenty-five year old orbit that is getting ripe for revision. The pair are currently closer than indicated. The most recent WDS observation (1981) gives 0.9" and 355°, from which we can infer the current separation to be between 0.9" and 1.0." The star has been suspected of variability, but this was not confirmed by photoelectric observations on twelve nights made by Dick Walker of the U.S. Naval Observatory Flagstaff Station.

Briefer notes on other pairs in the list are as follows:

A tough pair is **Couteau 286** discovered in 1968 by Paul Couteau. In the 7-inch Brian could not detect the secondary with certainty; the large magnitude difference provides the challenge here.

ADS 7695 is a cinch by comparison for 6- to 8-inch telescopes. The pair are conceiveably resolvable in a 2-inch, but the components are probably too faint to accomplish this easily.

ADS 7715 is also relatively wide and faint, but probably "gettable" in a 3-inch. The separation has been fixed since its 1830 discovery by Struve.

Because of its faint companion, **ADS 7744** was tough in the 7-inch. As the separation increases in the future, the pair will become an easier target in smaller instruments.

Another "routine" pair for smaller instruments is **ADS 8220** (90 Leonis). Glenn Chaple resolved this at 60x in his 3-inch reflector. Paul found it difficult but resolvable using a 2-inch mask over the 8-inch. At full aperture he saw the colors as blue-white and green-white. Both components are of mid-B spectral type, somewhat bluer than Vega.

One of the fainter pairs is **ADS 8263**, which Paul described as "a tiny glimmer . . . needs careful looking to find [in the 8-inch]." This one was too faint/close to be shown with a 3-inch stop over the telescope.

To avoid the confusion of discoverer names, we've used ADS (Aitken double star catalogue) numbers to identify entries in the table. This catalogue is the NGC of double stars and includes the vast majority of pairs accessible in modest apertures. Since the pairs for the article were selected from the *Sky Catalogue 2000*, all but Couteau 286 are bright enough to be plotted on the Tirion *Sky Atlas 2000*. Magnitudes labeled "V=" are photoelectric V (visual) magnitudes on the standard UBV system. Most of the individual magnitudes are computed from the combined photoelectric magnitude and the Δm (magnitude difference) based on visual estimates. These may differ from those published elsewhere; just keep in mind no data like these are cast in stone and are continually subject to improvement. Magnitudes without the V= heading are taken from the *Sky Catalogue* and unfortunately represent an amalgam of magnitude systems.

When a single separation and position angle are listed, it is the most recent observation given in the USNO *Washington Index Catalogue of Double Stars* (WDS), which summarizes data up to 1984. Multiple entries give ephemerides (ef-eh-mare-eh-deez) based on the most recent available orbits and show the motion of the pair over an appropriate interval one may interpolate for any desired date. Spectral types, from which true colors may be inferred, are mostly from the Yale *Bright Star Catalogue* and work published by Helmut Abt. Single entries here are for the combined type of the two stars unless otherwise noted.

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Variable Stars

Spring's Stellar Crown

by David H. Levy

Nineteen eighty-six marked the seventy-fifth birthday of the American Association of Variable Star Observers (AAVSO). To celebrate this milestone, the AAVSO had a special meeting last August, during which its new headquarters building was dedicated. At the meeting I was struck by the warm friendship and sense of family that hovers around amateurs who observe variable stars.

The paper sessions amply demonstrated that the cataclysmic variables like SS Cygni, as well as the ordinary Mira stars, which have been at the heart of most observers' programs for decades, are attracting more professional interest than ever before. A day of interesting reports on research showed the strength of this activity throughout the world, even in countries like Hungary and Sweden.

The new building contained an exhibit downstairs that portrayed the aggregate light curve of three-quarters of a century of AAVSO history. It is a long and productive history beginning in 1911, when a program existed for the few stars observable with the small refractors. As apertures and the interest of members grew, so did the membership and the numbers of stars observed. AAVSO's success rests squarely on the shoulders and the eyes of its observers. Congratulations on a job well done!

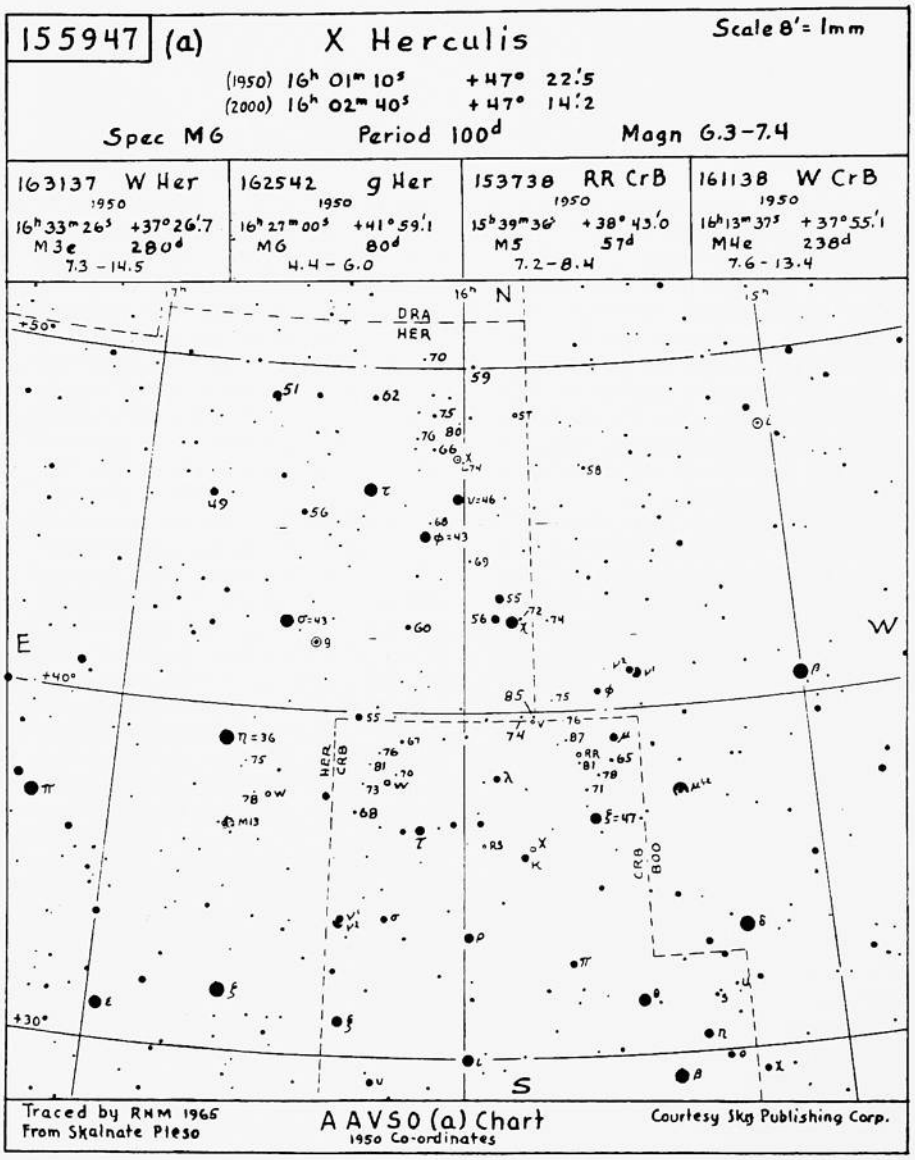
Never should we feel closer to variable stars than in spring. We have just come through the trials of storm and cold, especially Northern Hemisphere landlubbers. Winter comes when our hemisphere tilts slightly away from the Sun. This spring we look at some stars that change in brightness for different reasons.

R and **T Coronae Borealis** are two of the most interesting variables in the sky. They belong to a group of stars called the Northern Crown. Corona Borealis is Latin, from the Romans, who borrowed the name from the Greeks. This was the mythical crown given to Ariadne by her husband Thesus. After he left her, she hurled her starry crown into the sky.

154428 **R CrB**. The type star of one of the strangest classes of variables known, R CrB was both the first variable to be discovered in the Crown and, with the possible exception of T, it is also the most unusual. R's normal magnitude is 6.0, and it may stay that way for years — in fact between 1925 and 1934 it did just that. As it stays around 6th magnitude, R often varies slightly, dropping perhaps to 6.3 and then rising slowly again.

But if R CrB drops much below 6.5 magnitude, it isn't likely to rise again until it has plummeted *eight magnitudes*, dropping almost out of existence. This puts it far beyond the easy gaze of the unaided eye or binoculars, to where it is a difficult object through most amateur telescopes. Its drop may be as rapid as half a magnitude per day. When it finally reaches its 14th-magnitude minimum, it may stay there, varying slightly, for weeks and then fitfully and very slowly begin its climb back toward maximum light.

The cause of R CrB's mysterious behavior was a mystery until recently, though the exact cause of the fading is still unknown. Recent observations indicate that something is eclipsing this star — perhaps a shell, perhaps an eruption of sootlike material that slowly expands and obscures the star. In any case, amateur observations of R CrB-type stars (RY Sgr is another good example) are crucial. Early detection of a drop in brightness is extremely important. Since the fading episodes are lengthy, professional observers can plan observations somewhat in advance if they get early warning of a drop. This would allow systematic observations of



American Association of Variable Star Observers (2)

the enveloping cloud as it forms.

151731 **S CrB**. This well-observed Mira star varies through about six magnitudes. It sports a leisurely decline that takes almost two-thirds of its year-long period; then it begins returning at the same speed towards its maximum. Just before the halfway point in brightness, however, it speeds up and hurries toward maximum.

154639 **V CrB**. Another Mira star, V CrB, takes just over a year to go from maximum to maximum. Just fainter than 7th magnitude, the maximum is visible through a good pair of binoculars. The star reaches its maximum relatively quickly, taking only a third of its cycle to climb from minimum. The rest of its time is spent in a leisurely decline to a rather flat minimum around 12th magnitude. This star behaves in fairly regular fashion, although its maxima can vary by a few tenths of a magnitude from cycle to cycle.

161138 **W CrB**. With a maximum around 8th magnitude and a minimum near 14th, W CrB follows an almost strictly sinusoidal light curve. The star fades toward minimum at about the same rate it approaches maximum. Also, both extremes are quite sharp.

155229 **Z CrB**. Varying in magnitude from 7.6 to 14, this star goes through its eight magnitudes of variation in rapid succession, with both extremes of the light curve being sharp. The star's amplitude is so large that you could shuffle through several instruments during your observations. With binoculars you can catch the maximum, and with an 8-inch telescope you would be hard pressed to see its minimum. In fact, you *should* change instruments, because your estimates will be more accurate if the fainter of your comparison stars falls about two magnitudes brighter than the faintest star your instrument can detect. (When any star is close to your instrument limit, you can't estimate its brightness reliably.)

155526 **T CrB**. Not far from R CrB is another most unusual variable star — a recurrent nova. The first outburst of T CrB we know of occurred in 1866, when the 10th-magnitude star suddenly jumped to 2nd magnitude and then slowly faded. When variable star observing became popular early in this century, observers naturally turned to the old novae just to see what they were doing. In 1946 the observing paid off when T CrB erupted again, rising overnight to 2nd magnitude. Even when this star is faint it deserves study, for its 10th-magnitude minimum is not constant. Like all novae, T CrB is a binary system, and one member of this system is most likely a semiregular variable that causes slow oscillations observers commonly see.

163137 **W Herculis**. While you're looking at M13 some night, be sure to take in nearby W Herculis, a conveniently located Mira star. Its magnitude range, 8 to 14, is covered in a period of about a year. Falling and rising branches of the curve take about the same amount of time, although the minima are slightly sharper than the maxima.

081112 **R Cancri**. About 10° southwest of the Beehive Cluster (M44) lies a bright Mira variable with a period 5 days short of a year and a range of over four magnitudes. Its maximum of 6.8 is bright enough to be visible in binoculars, and the minimum of 11.2 is easily observable using a small telescope. To find R Cnc, go about 1½° degrees north of the 4th-magnitude Beta (β) Cancri.

084917 **X Cancri**. One of the best bright variables of spring, this star is located southeast of the Beehive Cluster. Its range of 5.9 to 7.3 means it is bright all the time and easily followed in binoculars. Its period of 165 days is slow for a star of such small amplitude, which means you should observe it only once every month.

085211 **RT Cancri**. Range 7.3 to 8.6. This variable lies about 2° south of α Cancri and is also southeast of the beautiful cluster M67. A red star of M5 spectral type, this semiregular star has a period of 90 days — thus you'd be wise to observe it once week. This presents a problem, however. Remember that you need constant conditions for accuracy for observing red semiregular stars, since the Purkinje effect ("spurious red buildup") in your eye differs with the amount of background light. The Moon's changing phases make these constant conditions hard to find. Therefore, observe RT Cnc when the Moon is not in the sky if you can. This will not always be possible, so make a note in your records when you think the Moon has interfered.

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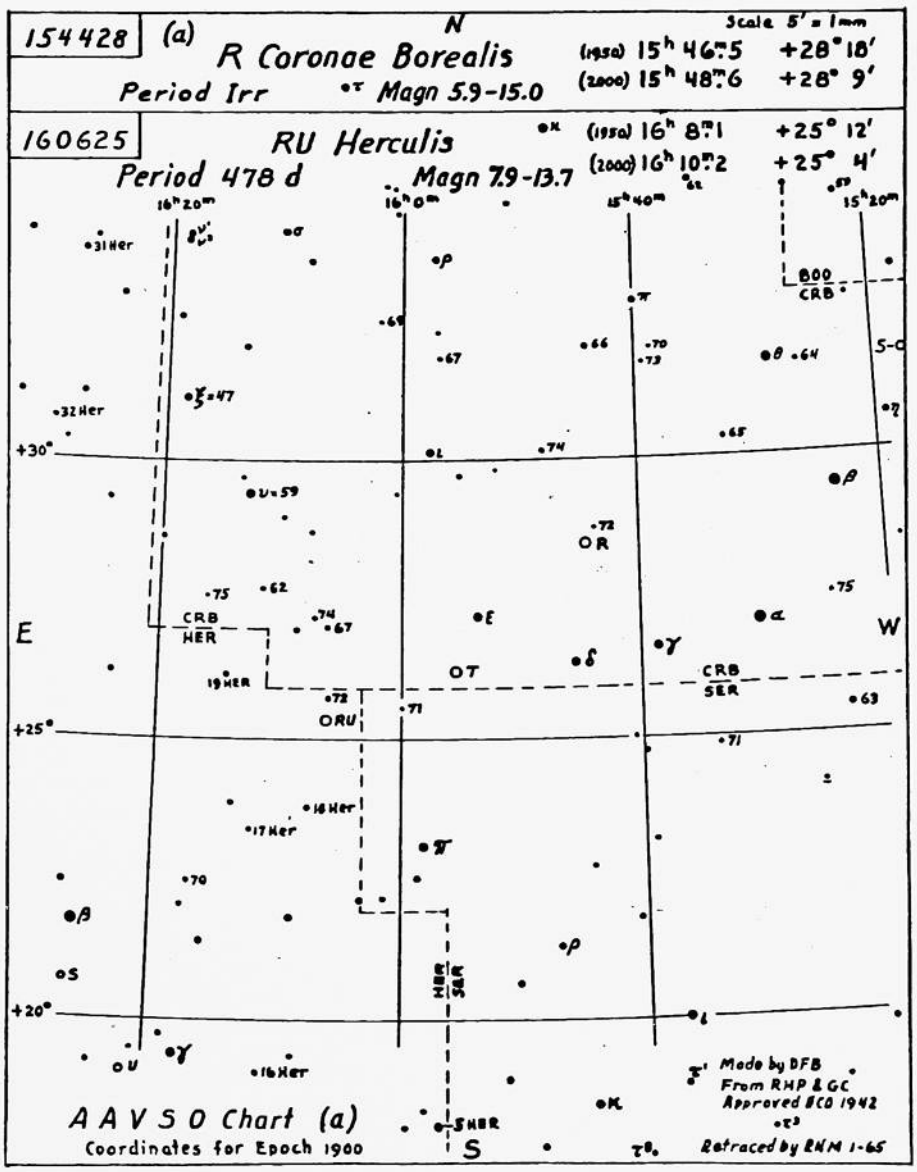


DSM Reviews

The Study of Variable Stars Using Small Telescopes
John R. Percy, ed.
265 pages, cloth, $34.50
ISBN 0-521-33300-8
Cambridge University Press (1987)

This book is the proceedings volume from a symposium on variable stars held at the University of Toronto in July 1985. The event was sponsored by the American Association of Variable Star Observers, the International Amateur-Professional Photoelectric Photometry group, and the Royal Astronomical Society of Canada. The book contains a wealth of extremely interesting papers written by a distinguished group of mainly Canadian astronomers and should fascinate those interested in the current state of research on variable stars.

Among the papers are topics as specific as "Variable Stars as Targets for Long-Term Coordinated Multisite Photometry" by the Belgian astronomer C. Sterken, and as general as "Searching for Periodicity in Astronomical Data" by the University of Toronto's Alex Fullerton. It's difficult to argue that a wide audience could glean much of immediate value from the former paper; the latter is of a more practical nature to most of us. It is interesting to note that Fullerton's conclusion warns heavily against believing periods in astronomical data without extensive observational confirmations; methods should be "tested comprehensively using both simulated and real data." This is not something I'm likely to do next week, but it is entertaining to read about.

An interesting paper by Elizabeth Waagen of the American Association of Variable Star Observers describes archiving variable star data. This account is fun to read and far different from the usual stuff you get in proceedings books. Waagen briefly reviews the history of AAVSO archiving and then describes how it is done today, from monthly reports in the mailbox to updated light curves generated by a DEC computer. This is the sort of stuff I'd prefer to see more of in proceedings books.

The Study of Variable Stars Using Small Telescopes is a handsome book produced with a laser printer and fine quality paper. It certainly contains a wealth of information on the subject. I suppose my only complaint with this product is that it is mislabeled: its title clearly implies that it is a book about observing variable stars with little telescopes in one's backyard. It isn't. The advanced amateur interested in semi-technical aspects of variable stars should snatch this book up; the beginner should ignore it.

Astrophotography II
Patrick Martinez
174 pages, paper, $18.95
ISBN 0-943396-13-1
Willmann-Bell, Inc. (1987)
[publisher's address: P.O. Box 35025, Richmond, VA 23235]

This octavo-size manual on astrophotography carries the subtitle, "Featuring the Techniques of the European Amateur," and is intended to supplement the American amateur's version by Barry Gordon, *Astrophotography*.

Martinez is a well-known French amateur and General Secretary of the Societe d'Astronomie Populaire. He offers a curious mix of material ranging from the definition of a camera to advanced techniques like film hypersensitization, tri-color imaging, and unsharp masking. At first glance, you wonder if such a vast spectrum of information can really exist on 174 small pages.

On closer inspection, one discovers that this book is not a literary explanation of how to go about astrophotography. Rather, it is organized more like a reference book with brief, concise definitions of terms and concepts that are often explained using line diagrams or small photos. The entries — I.4.4.5. is "The Principle of Magnification; VIII.2.4.4. is "Star Trails" — were translated from French, so they don't always read smoothly. And although this book is touted as being for beginning, intermediate, and advanced amateurs, it reads like a textbook.

This book retails for $18.95, which is rather expensive for its size. Somewhat disappointingly, the publisher has included a section of thirteen color photographs that don't significantly add to the book's usefulness but probably significantly added to the book's price tag. Some of these color shots, at least on my review copy, show printing problems due to poor color separations or slightly bad registration, which only adds fuel to the question, "Why were these included?" The black and white photos, however, generally reproduced in excellent quality and the entire book is printed on heavy, coated paper.

Despite these squabbles, the information in this book is excellent and does provide valuable reference material particularly for intermediate and advanced astrophotographers. On this basis, I can recommend it highly.

Astrophoto VII
John Sanford, ed.
63 pages, paper, $11
Orange County Astronomers (1987)
[publisher's address: 2215 Martha Avenue, Orange, CA 92667]

Astrophoto VII is the proceedings volume from the seventh southern California conference on astrophotography, held at Moorpark College in March 1987. The event was sponsored by the Ventura County Astronomical Society, the Orange County Astronomers, and the Moorpark College Science Club and drew 260 amateur astronomers.

Several of the papers in this volume are well done and will prove useful to intermediate and advanced astrophotographers. Among these is Bill Iburg's "A Survey of Current Color Films for Gas Hypering," describing the Oregon photographer's recent experiments with new color films. Iburg chose 3M Color 200, Agfacolor 200 and 400, Fujicolor HR 200 and 400 Super, Fujichrome RD 100 and RH 400, Kodacolor VR 200, Kodacolor VR 400, Ektachrome 200 and 400, Konica SR 200 and 400, and Konica SR 1600. Using strips of hypered film, he then photographed M27 and found that for grain, color balance, and contrast, the Konica films were hands-down winners.

Also included in the volume are interesting essays. "Educational Astrophotography for the Amateur" by Lee C. Coombs implores astrophotographers to take sequential photographs of sky events so that they can recreate the scene for others. "Sharing Astronomy with the News Media" by Ronald Royer and Steven Padilla reflects on what can be done to "spread the word" about amateur astronomy.

This is an interesting and enjoyable volume to leaf through. However, something disturbs me about these Astrophoto proceedings volumes: the great majority of the astrophotos reproduced in them simply appear between articles and have no relation whatsoever to what's being discussed. Note to authors for Astrophoto VIII: include good, relevant photographs that you've taken along with papers, and readers will get more out of them. *David J. Eicher.*

Scanning the Literature

December 1986-February 1987

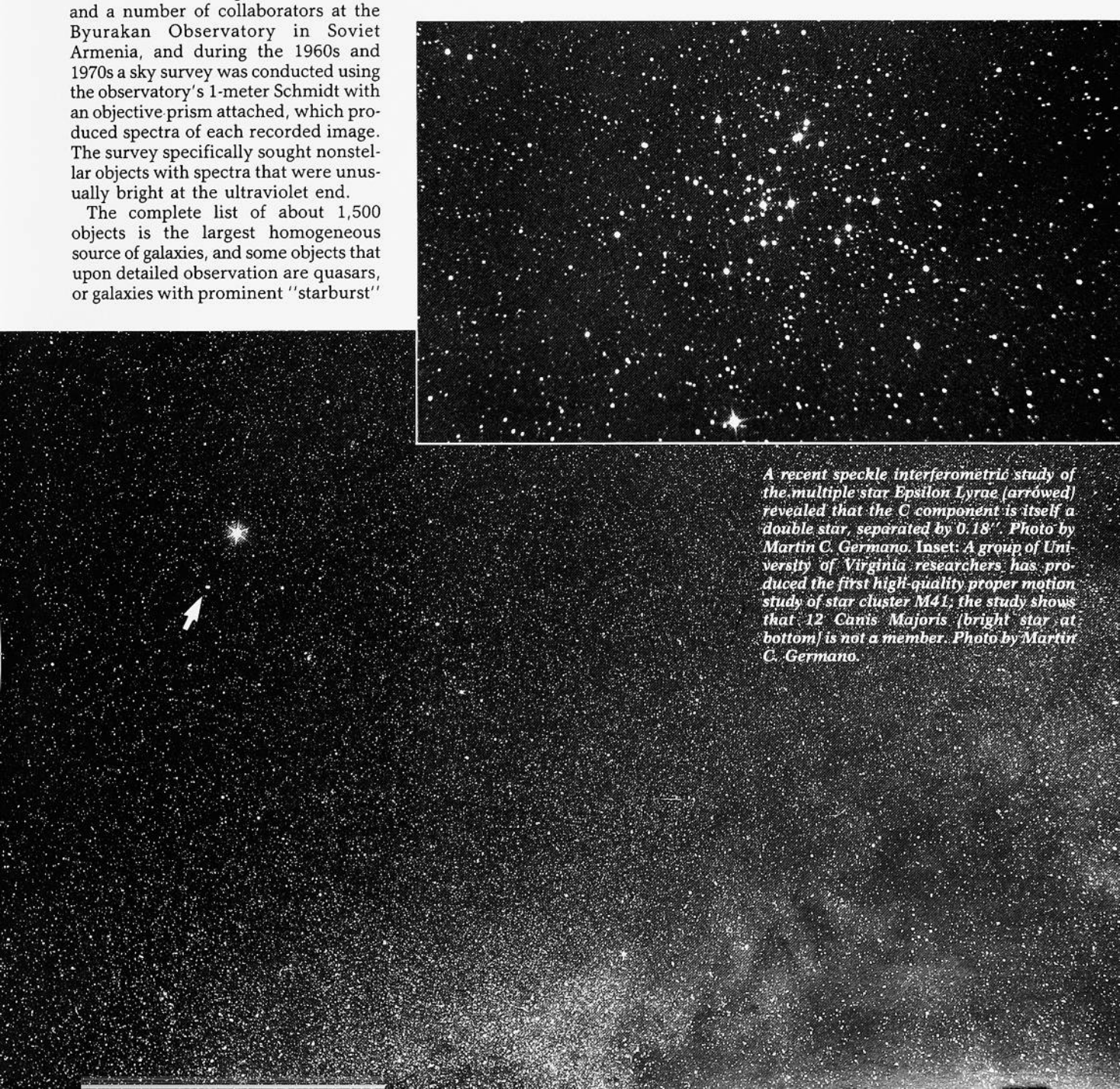
By Brian Skiff

Two large comprehensive catalogues of extragalactic objects have been added to the literature. The first is "A Catalog of Markarian Galaxies" by Joseph Mazzarella and Vicki Balzano (*Astrophysical Journal Supplements* [ApJ Suppl.] **62**: 751, December 1986). Markarian galaxies were identified by B. E. Markarian and a number of collaborators at the Byurakan Observatory in Soviet Armenia, and during the 1960s and 1970s a sky survey was conducted using the observatory's 1-meter Schmidt with an objective prism attached, which produced spectra of each recorded image. The survey specifically sought nonstellar objects with spectra that were unusually bright at the ultraviolet end.

The complete list of about 1,500 objects is the largest homogeneous source of galaxies, and some objects that upon detailed observation are quasars, or galaxies with prominent "starburst" star-forming regions covered with emission nebulosity. The summary catalogue provides accurate positions and complete bibliographic references as well as radial velocities, spectral information, detections outside visible wavelengths, and so on.

The entire 250-page January 1987 issue of the Supplements *Astrophysical Journal* is devoted to "A New Optical Catalog of Quasi-Stellar Objects" by Adelaide Hewitt and Geoff Burbidge. Information is provided on 3,681 objects: 3,594 quasars and 87 BL Lacertae objects (which are "almost QSO's" or perhaps "used-to-be-QSOs"), included with the proviso that each has at least one published redshift. The extensive listings, which include names, magnitudes and colors, degree of polarization, and more, measure clear across the electromagnetic spectrum from x-ray to radio wavelengths.

The distribution of redshifts shows a strong peak between z=1.5 and 2.5, which corresponds to a magnitude peak between 18 and 21. There are relatively few quasars at higher redshifts though



A recent speckle interferometric study of the multiple star Epsilon Lyrae (arrowed) revealed that the C component is itself a double star, separated by 0.18". Photo by Martin C. Germano. **Inset:** *A group of University of Virginia researchers has produced the first high-quality proper motion study of star cluster M41; the study shows that 12 Canis Majoris (bright star at bottom) is not a member. Photo by Martin C. Germano.*

astronomers have searched for others. This distribution figures significantly in ideas on quasar ages and lifetimes and will become especially diagnostic when we figure out how far away these beasts really are.

What's *z*? The ratio of the wavelength shift of a spectral feature and the rest wavelength of that feature. If the Lyman α line of hydrogen (rest wavelength about 1200 angstroms) appears at 360 angstroms, the quasar's redshift is z=2.0 since the shift is 2400 angstroms. What's Lyman α? What's an angstrom? Okay: if twenty-five readers send Dave Eicher a note by July 1 saying they want the scoop on quasars, then we'll do it (and give viewing tips for the brightest objects.)

Up in the northeastern corner of Leo on the border of Leo and Coma Berenices is a mixed collection of spiral and elliptical galaxies centered on NGC 4005. As the result of obtaining radial velocities for objects in the region, Barbara Williams of the University of North Carolina has come to an interesting conclusion ("The NGC 4005 Group: A Rotating System of Galaxies?", *ApJ* **311**:25, December 1). She obtained accurate redshifts for two dozen galaxies in the group.

There is a strong correlation between the velocity of a particular object and its location: galaxies on one side have systematically lower velocities than those on the other side of the group. Williams suggests that the system may be modeled as a rotating disk seen roughly edge-on spinning with a period of no more than a few billion years (much shorter than the lifetimes of galaxies). A photo of the group is included with the article. The brightest members are visible with 8- to 12-inch telescopes from a dark site.

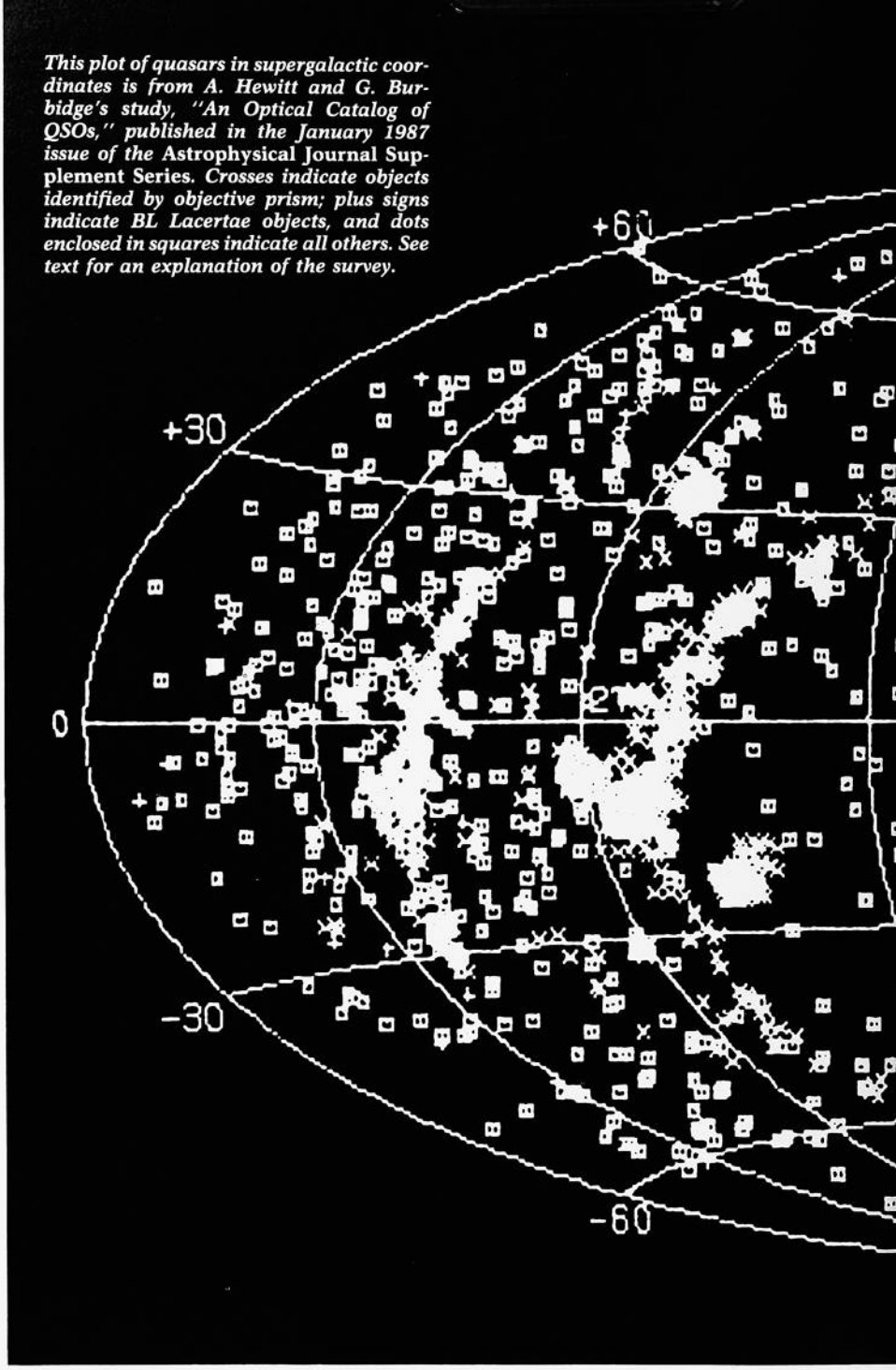
Two good studies of open clusters have appeared in recent journals. In the January 1 issue of the British journal *Monthly Notices* of the Royal Astronomical Society, Alistair Walker and C. David Laney discuss a fairly faint cluster in Scutum ("CCD Photometry of Galactic Cluster Containing Cepheid Variables. IV. NGC 6649," *MNRAS* **224**:61). This cluster includes the variable V367 Scuti as one of its brightest stars at about magnitude 10.5.

It and the cluster would be more prominent if they did not lie behind the dark rift of the Milky Way in Scutum, which dims them by over three magnitudes. The paper provides a color-magnitude diagram for four hundred stars to V magnitude 20 in this rich, young cluster, which lies at a distance of about 1600 parsecs.

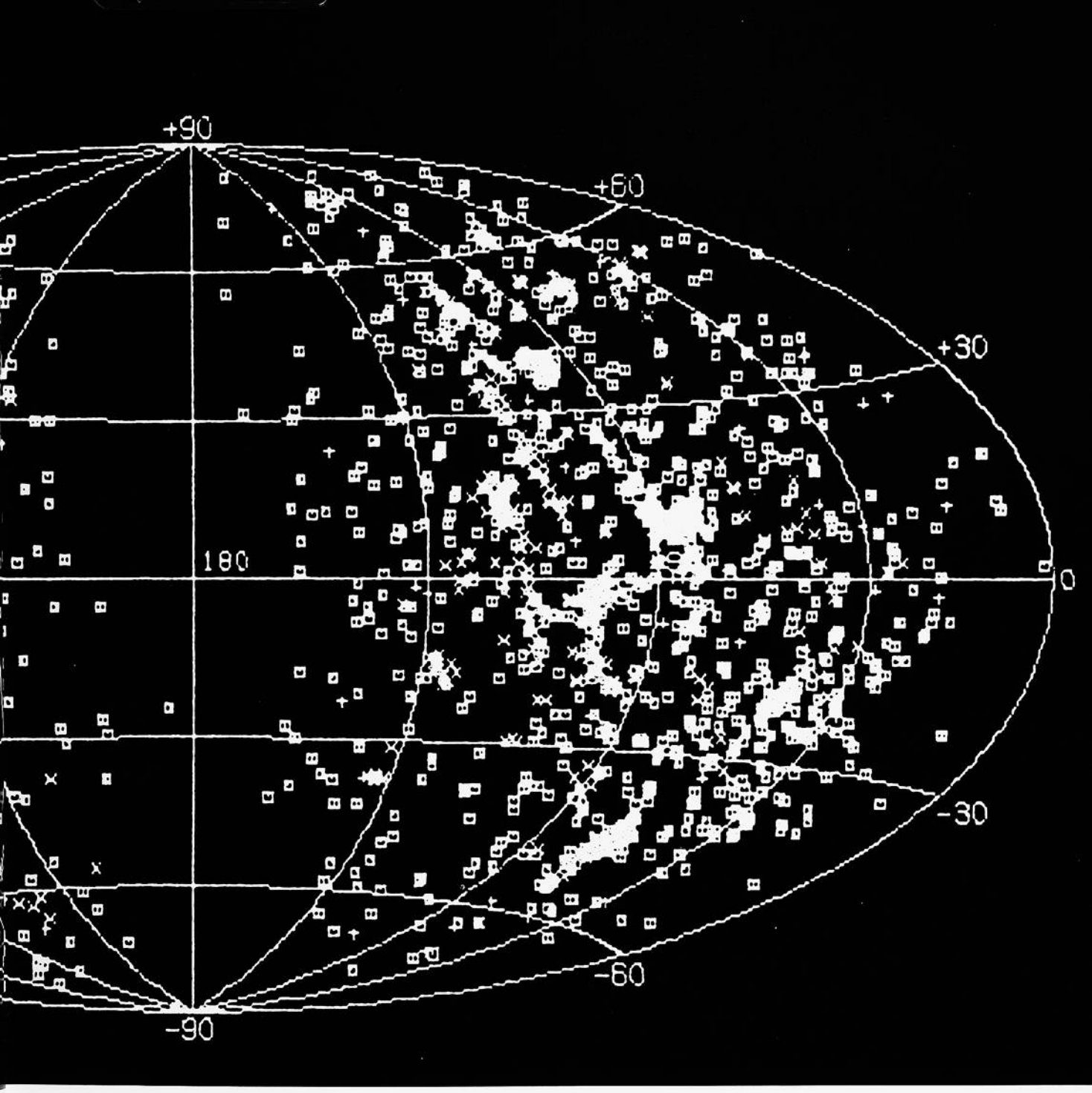
The first decent proper-motion study of the naked-eye cluster Messier 41 has been published by a group led by Philip Ianna of the University of Virginia ("Membership in the Open Cluster NGC 2287," *Astronomical Journal [AJ]* **93**:347, February 1987). Photographs from the McCormick 67-cm refractor taken in 1922-23, 1970, and 1978 were used. In addition to the motions, UBV photometry was obtained for about 150 stars brighter than twelfth magnitude —the best measure in the literature for this already much-studied cluster. Earlier work on M41 has shown that it contains several orangish K-type bright giants, peculiar stars, and spectroscopic binaries (practically all the bright B-type members are binaries).

These proper motions in combination with the new photometry and earlier work indicate that most of these stars are cluster members. However, 12 Canis Majoris, the sixth magnitude star off the southeast edge of the cluster, is not a member because of its large motion on the sky.

A remarkable result concerning doubles among naked-eye stars is presented by Harold McAlister and a group of collaborators from Georgia State University, Space Telescope Science Institute, and Lowell Observatory ("CCD Speckle Observations of Binary Stars. I. A. Survey for Duplicity among the Bright Stars," *Astronomical Journal* **93**:183, January 1987). The team observed 672 stars selected from the Yale Bright Star Catalogue with a CCD speckle interfer-



This plot of quasars in supergalactic coordinates is from A. Hewitt and G. Burbidge's study, "An Optical Catalog of QSOs," published in the January 1987 issue of the* Astrophysical Journal Supplement Series. *Crosses indicate objects identified by objective prism; plus signs indicate BL Lacertae objects, and dots enclosed in squares indicate all others. See text for an explanation of the survey.



ometric camera on the 3.6-meter CFH telescope. The purpose of the observations was determining the frequency of close binaries among a random selection of stars. The fine-guidance sensors for the Hubble Space Telescope will fail to lock on for tracking if there are two or more stars of similar brightness within the range 0.04″ to 0.25″. These separations are at the limit or well below the limit detectable by visual methods but are comfortably easy with speckle interferometry.

The stars were picked without considering whether or not they were known binaries. The group was able to observe so many stars in only a four-night run because the large-aperture telescope is semiautomated and because the speckle camera requires only a one-minute integration to accumulate enough data for these relatively bright stars.

The data were reduced blindly —without reference to double star catalogues. All previously known doubles wide enough to be resolved were "rediscovered," and fifty-two new pairs were found, including some new components to known wider pairs. In the critical separation range under a quarter of an arcsecond, the observed sample indicates a binary frequency *triple* that previously known. The folks at the Space Telescope Institute are working on how to get around this problem.

Among the surprises are two new pairs easily discerned visually. One is HR 5818, a 6th-magnitude star in Draco (2000 coordinates: 15h36.0m +54° 38′), which is separated by 0.51″. The other is 14 Lacertae, a slightly variable Be star (=V360 Lac), which ought to be visible in a 6-inch telescope (separation 0.97″). Also interesting is the discovery of duplicity of the C component of $\varepsilon^{1,2}$ Lyrae — at just 0.18″ separation — though you'll need a sharp 24-inch or larger telescope and primo conditions to spot it.

Interacting Galaxies NGC-5394/5

U.S. Naval Observatory photo